American Society of Civil Engineers.

PROCEEDINGS.

Vol. II, January, 1876.

MINUTES OF MEETINGS.

(Abstract of such as may be of general interest to members.)

OF THE SOCIETY.

JANUARY 5TH, 1876.—A regular meeting was held at 8 o'clock P. M.

The vote on admission to membership was canvassed and the following declared elected :—Corresponding Member, Mr. Ernest Pontzen of Vienna, Austria; Members, Messrs. Charles G. Darrach and Rudolph Hering of Philadelphia, Pa.; Alphonse Fteley of Boston, Mass.; Peter A. Peterson of Toronto, Can.; Clinton B. Sears of Engineer Corps U. S. A. and Henry R. Worthington of New York; and Junior, Henry D. Blunden of New York.

Replies to circulars issued under resolution adopted at the last Annual Meeting, referring to the organization of a Civil Engineers' Insurance League, were also canvassed, and it was announced that 59 Members and Juniors would join the League and 62 would not.

Communications from George E. Gray and William P. Shinn of December 13th, relating to this League, and from the latter, of same date, "concerning Conventions;" and from W. Milnor Roberts of November 22d, proposing a dinner to Sir Charles A. Hartley, with reply, were read.

The President was authorized to add at his discretion to the members (residing in Philadelphia) of the Committee on Eighth Annual Convention.

The Amendments to the By-Laws recommended December 1st by the Board of Direction to the Society for adoption, were considered section by section and action taken thereon:—

Addition to Section 1, was amended* as follows, and reported to the Society for adoption at the next regular meeting;—

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* Changes are in *italics*.

Addition to SECTION 1. A Convention of the Society for professional discussion and social intercourse shall be held annually at such place as the Society may determine, and be presided over by a Chairman selected from among Members not officers of the Society. During the Convention, a regular meeting of the Society to be presided over by the officers of the Society, *may* be held for the transaction of business.

The officers of the Society *may* give a reception at the Society's rooms, on the evening of the second *and the fourth Wednesday* of each month between October and April, for the purpose of informal professional conversation and social intercourse. Regulations concerning refreshments and the invitation of guests *may* be made by a committee appointed for the purpose, *but shall be without expense to the Society.*

The following sections were corrected and then adopted:—

Addition to SECTION 16. When, however, the Library Committee does not feel authorized to publish a paper, they may provide an abstract thereof, which, when approved by the author, may be published instead of the original paper.

SECTION ... Special committees to report upon engineering subjects shall be authorized only by a majority of the votes cast by the Society, and in the following manner: Any resolution proposing such a committee shall be referred to the Board of Direction, which shall examine the same and report to the Society *a concise statement of the argument for and against the appointment of such committee, which statement shall be printed and issued to the Society with letter ballot;* or, if the Board fails to report within one month, the letter ballot shall be issued without comment; or, the Society may vote by ballot at the Annual Meeting or in Annual Convention upon such resolution, within one month after it has been submitted to the Board of Direction.

SECTION ... The President of the Society shall have the general supervision of the business and correspondence of the Society; he shall be an honorary member of all committees, but shall have no vote on such *committee.*

The next section considered was:—

SECTION ... Upon application to the Society for professional service, the President and Board of Direction shall in each case take such action as they may deem best. If they appoint members for the service, the President shall make the nominations, subject to revision and addition by the Board.

For this, it was proposed to substitute :—

1st. Upon application to the Society for professional service, the President shall in such case recommend members therefor, subject to revision and addition by the Board of Direction;—and

2d. Applications to the Society for professional service shall be referred to the President and Board of Direction for suitable action.

After discussion, this section was made a special order at the business meeting of the Eighth Annual Convention.

The last section was referred back to the Board of Direction for revision; it is as follows:—

SECTION ... Annually, on November 1st, all members shall be classed as Resident or Non-Resident, and the Treasurer shall consider those as Resident who do not on notification certify to the Secretary before that day, their residence otherwise.

JANUARY 19TH, 1876.—A stated meeting of the Society was held at 8 o'clock P. M.

George S. Morison, C. E., of New York, read a paper on the "New Portage Bridge," and a discussion followed.

A communication from Arthur L. Ford, of January 15th, referring to the behavior of cement under different circumstances, was presented; the Secretary made informal report for the Centennial Commission of the Society; Henry Pettit described the Exposition Buildings, and stated what space had been secured for the presentation of American engineering under the auspices of the Commission; and, upon motion of William J. McAlpine, he was thanked for his effectual efforts in the matter.

OF THE BOARD OF DIRECTION.

JANUARY 5TH, 1876.—A stated meeting was held at 3 o'clock P. M.

Proposals for admission to the Society were considered; the Treasurer's report for the past month presented; appropriations for the current month made; James P. Kirkwood, Alfred W. Craven, Julius W. Adams, George S. Greene, and James O. Morse were appointed a committee to arrange the names of members of the Society in order of seniority, that a list may be made, for issue in due course of the certificates of membership, and other routine business done.

NOTES AND MEMORANDA.

THE CENTENNIAL COMMISSION OF THE SOCIETY.

With a view to aid in a proper representation of American engineering progress and practice at the Centennial Exposition, the Society, at its Annual Meeting, appointed Theodore G. Ellis, James R. Croes, Robert Briggs, Octave Chanute, Alexander L. Holley, William Sooy Smith, and William P. Shinn, a committee to consider the subject, and to take such action as might seem desirable.

It was proposed; *first*—to urge engineers who are or have been in charge of important, novel or interesting works, railroad, canal and other public corporations, and especially builders or manufacturers willing to make their works known, to present such specimens, models, plans, photographs and descriptions as shall give to visitors at the Exposition an adequate and correct idea of engineering progress and practice in this country, and to exhibit the same either in groups or under the general classification, as may be preferred; and *second*—to have a secretary in attendance during the Exposition, to give such detailed information as by an inspection of the models, plans, &c., exhibited, visitors may be led to ask for. It is expected that arrangements will be made to have memoirs prepared, setting forth the progress and present state of the several branches of engineering in this country.

With this view, the following sub-committees were formed and chairmen appointed (who, with the President, *ex-officio*, constitute the Centennial Commission of the Society):

I. On Railroads and Rolling Stock; William P. Shinn of Pittsburgh, Pa.

II. On Bridges and Bridge Construction; Octave Chanute of New York.

III. On Water Works; J. James R. Croes of Yonkers, N. Y.

IV. On River and Harbor Improvements; Theodore G. Ellis of Hartford, Conn.

V. On Canals and Inland Navigation; William J. McAlpine of Albany, N. Y.

VI. On Hydraulic Motors and Machines; Charles E. Emery of New York.

VII. On Foundations and Masonry; William Sooy Smith of Maywood, Ill.

VIII. On Surveying, Geodesy and Landscape Engineering; John Bogart of New York.

IX. On Sewerage and Sanitary Engineering; J. Herbert Shedd of Providence, R. I.

X. On Light-Houses and Signals; John G. Barnard of New York.

XI. On Steam Engineering; Robert Briggs of Philadelphia, Pa.

XII. On Metallurgical Engineering; Alexander L. Holley of New York.

XIII. On Gas Engineering; James H. Armington of Brooklyn, N. Y.

XIV. On Mechanical Engineering; Robert H. Thurston of Hoboken, N. J.

XV. On Electric Engineering; Stephen Chester of New York.

XVI. On Correspondence and Circulars; G. Leverich of New York.

XVII. On Rooms and Representation; Thomas C. Clarke of Philadelphia, Pa.

XVIII. On Arrangements and Space; Henry Pettit of Philadelphia, Pa.

XIX. On Finance; W. Milnor Roberts of New York.

The Commission duly organized, and has held weekly meetings (on Wednesday evening), at the rooms of the Society.

A committee has been appointed to co-operate with the American Institute of Mining Engineers, on routes and works of engineering interest, on facilities at rooms in Philadelphia, and on engineering with reference to the Centennial; and Mr. Holley made chairman, with power to appoint others.

The Chairmen of Sub-Committees on engineering topics, were constituted a committee instructed to procure memoirs from members of the Society, on the state and progress of civil engineering in America, and as illustrated at the Exposition, and to cause the same to be edited for publication.

A room 24 x 48 feet, on the second floor of the Main Exhibition Building, has been secured, and formal application made for at least 1 500 square feet of floor and an indefinite amount of wall space.

Assistance in this matter is solicited from members of the Society and others, either in contributing specimens, models, plans, photographs and descriptions to be presented, or by inducing others to do so. As the time is short, it is desirable that preparation should begin at once.

The following is from circulars already sent out by Chairmen of Sub-Committees; others will be issued in due course. In reference thereto, members will please address the Chairman of the particular Sub-Committee:

On Water Works.—The subject of American water works, for the supply of cities and towns, will be illustrated by an historical and descriptive memoir, and drawings, photographs and models of important or peculiar structures. To aid in the preparation of such memoir, and the presentation of the subject fully, you are requested to furnish such information on the following points as you are able to give, relating to the works with which you are connected.

1. When were the works constructed? Names of engineers by whom designed and built.

2. Under what organization were the works built?

3. Under what organization are they managed?

4. What is the source of supply, and the area and topographical and geological character of its water shed?

5. What is the annual rain fall on the water shed? Send tables of same for several years, if practicable.

6. Have you tested the discharge from streams; if so, with what results?

7. Quality of water; analysis made of it.

8. Cost of works; original and additions.

9. Annual cost of maintenance of works.

10. Population of town and number of consumers, and quantity of water used.

11. Character of supply; gravity, steam pumping or water power.

12. If by gravity; size, form and grade of conduit.

13. If by pumping; description, capacity, duty of machines. A skeleton sectional elevation of engine and pump, on scale of one-twelfth or one-twenty-fourth, is particularly requested, also indicator cards from pump and from engine, and lift of water.

14. Reservoirs; size, method of construction.

15. Distribution; kind, size and length of pipes. Durability of pipes, mode of protection against corrosion and incrustation. For-

mula used for thickness of pipes. Notes on leaks and on loss of head.

16. Gates, stop cocks, hydrants; kind and number. Comparative economy and efficiency of varieties used.

17. Meters; kind and numbers used; correctness and durability.

18. Have you made experiments on flow in pipes and conduits; if so, please give results.

19. Have you used filter beds or galleries; if so, with what result?

20. Note any special difficulties in construction, and method of overcoming them.

21. Failures of structures, and probable reasons for same.

22. Copies of reports and documents embodying valuable information, are particularly requested.

23. Drawings of important structures, and of any peculiarities of detail in works; sections of dams and embankments and conduits, and plans of gate houses and engine houses are desired; uncolored tracings preferred, with scale drawn on them, and dimensions figured as far as possible; photographs also requested.

24. The object of the exposition being to furnish to foreign and American civil engineers practical information regarding American water works engineering, in a condensed form, you are requested to make your statements as concise as possible, to conform your replies to the above classification, to write on fools-cap, or legal cap paper, and only on one side of the sheet.

On River and Harbor Improvements.—It is of great importance to make as complete a representation as possible, at the Centennial Exhibition in Philadelphia, of plans and models of executed river and harbor improvements in the United States.

If it lies in your power to furnish any such plans or models, that you may now have or are willing to prepare, please to notify at your earliest convenience the chairman of this committee, who will attend to their reception and proper placing in the space assigned to the American Society of Civil Engineers.

An early notification of what articles you can contribute, with a memorandum of the space required for them, will be deemed an especial favor.

On Electric Engineering.—* * * Among the branches which it is proposed to illustrate, by the exhibition of drawings, photographs, descriptive statements giving details of construction and operation, models and working apparatus, is that of electric engineering, in all its phases.

It is not proposed that the Society shall constitute itself an advertising agency for the exhibition merely of articles of competitive manufacture; it desires only to have exhibited under its patronage, that which shall best illustrate American progress in electric and telegraphic science; and to that end it cordially invites the presentation of such drawings, descriptions, models or apparatus, as may best demonstrate new discoveries, or new applications of the science to useful purposes.

With this in view, we respectfully invite from you such suggestions upon the subject as you may be disposed to make, and early information whether you will yourself take part in such Exposition, and in what direction and to what extent.

On Bridges and Bridge Construction.—The Sub-Committee appointed to promote a proper presentation of American Bridges and Bridge Construction at the Centennial Exposition, hopes to secure your assistance to make the exhibition in this respect both creditable and complete.

American engineers have long enjoyed the prestige of having built the longest, boldest and most important wooden bridges in the world. Within the last fifteen years they have turned their attention towards the erection of iron bridges, and already a distinctive American practice has grown up, which, in consequence of the marked improvements and progress of the last five or six years, is claimed by some of them to be in advance of European practice, in regard to economy of materials, facility of erection and possible length of spans of iron and steel bridges.

This fact, if it is a fact, the committee desires to establish. It does not propose to supersede or to alter any arrangements which intending exhibitors have already made, and will make a separate exhibit of those contributions only, which the parties furnishing them shall specially request it to take in hand. It intends mainly to secure such concert of action as shall lead to an adequate presentation of our recent progress and shall best attract the attention of visitors while furnishing them any further information they may require.

For this purpose it is proposed to have an office, at which a secretary shall be in attendance, in some central part of the Exposition building, and to which visitors shall be referred and directed by cards appended to the individual exhibits. These cards, which are to be made as conspicuous as possible, should be appended to all the exhibits in charge of the committee, whether entered by the exhibitors themselves or by the committee, and would

refer whatever visitor might become interested by the object exhibited, to the secretary in attendance, from whom he might obtain such albums, lithographs, circulars or cards, as the exhibitors shall wish to distribute; or, more important still, receive information as to the readiest way of visiting the works themselves, and becoming acquainted with their builders.

It is also proposed that the secretary shall keep a record of the names and temporary address of the visitors, in order that proper attention may be shown to them.

With these views, the following suggestions are made:

I. That engineers, or others, who are in possession of models, plans or photographs of interesting bridges, whether of wood, iron or other material, shall prepare the same for exhibition, and append thereto the name of the contributor and such description and information as may seem required. It is especially hoped that pains will be taken to represent the earlier bridges erected in this country, so as to give the exhibit an historical value. Arrangements may be made by contributors for exhibition, through the commissions appointed by the several States—but the committee will take charge of the models, plans, &c., if desired, obtain the necessary space, and group and arrange them so as to make the display as effective as possible.

II. That builders, manufacturers and designers of bridges, should prepare the following: 1st. Models, generally upon a scale of one-eighth or of one-fourth of an inch to the foot (one-ninety-sixth or one-forty-eighth of real size), of such of the more important of their works as they may desire to make known; together with full size, or half, or even quarter size models of the details of the joints and connections, especially those in which the American differs from the European practice. 2d. Original or traced drawings of the plans of the less important of their works, together with photographs representing the same and, whenever possible, the mode of their erection. 3d. Printed statements to be furnished to the secretary for distribution, concerning the same. It is suggested that the most effective method of furnishing this information would be through illustrated albums, giving the location, date of building, description, spans, width and depth of trusses, weights and amounts of materials, loads assumed, and factors of safety adopted, &c., of the bridges built or designed by them. These albums could either be given away or sold to enquirers at about cost, as the contributors might direct.

It would greatly be preferred that this class of contributors should make their own arrangements for obtaining space, and display of their exhibits, but the committee will take charge of this at their expense, if required.

III. That parties who may receive this circular, shall advise the Chairman of the Committee, at the earliest moment possible, as to what action they propose to take in relation thereto; or shall inform him in case they know of any parties who are in possession of any models or plans of bridges, which it would be desirable to exhibit, as well as to favor him with any suggestions that may occur to them, as to the best method of representing creditably American bridge engineering at the Centennial Exposition.

SELECTIONS FROM CORRESPONDENCE.*

SELECTING PAPERS TO BE PUBLISHED.—One member writes:—I notice that the Board of Direction † "suggests for consideration whether By-Law, Section 16, governing publication, should not be so modified that papers have the preference which are most free from tables and formulas and require the least illustrating," or as it sounds to me, whether the Society should not put a premium upon papers designed upon the Aristotlean method of discussion of engineering subjects; that is, papers which treat such matters by argument, reasonings, logic, the voice of authority, &c., &c., all of which is cheap to write and correspondingly cheap to print. I trust that before the Society commits itself to such a policy it may be allowed to reflect upon the matter, and then cast an intelligent vote upon it. * * * It is surely sufficient to leave the selection of communications to be printed, (*and it seems to me, that any communication should be excluded from print, ought*, under our aimed-for conditions, *to be the exception*) as untrammeled as possible to a discerning publication committee. The only limit should be the total possible expenditure, and our aim to have a fund sufficient to print everything of value and which points in the direction of progress.

As far as the matter of illustrations goes, I venture to affirm that the one great need of our American publications is illustration, the more unpardonable when we reflect upon

* Under this head it is proposed to give, from letters received, excepts of general interest.

† Proceedings, Vol. 1, page 308.

the multitude of comparatively inexpensive illustration-producing processes which to-day are at the command of the profession, such as photo-lithography, heliotypes, photo-engraving, and many more. Why, is it not disgraceful, not to use too strong a word, that our American works of engineering may be found illustrated, and for the matter of that described, generally in one, two or three foreign "tongues," when the same work will be sought for in vain in any American periodical publication.

As a Member, I have hoped to see the Society take radical ground against this state of affairs and tend, by all means in its power, to better this lack of representation of American subjects in American prints, and I have *labored* under the idea that it was for this very purpose that the Fellowship Fund was instituted. I doubt not many have thought the same and others have paid their money under this very idea and for this very purpose. I trust, for one, that no such rule will ever be adopted, as I hold that it would mark the commencement of a period of decline in the utility, in the very reason, for the existence of the Society.

The remarks above on illustrations are no less true with regard to what is termed in the report generically as "formulas." There are formulas and—formulas; a paper containing many formulas may be of little or no value; if the latter, then do not print it. Another equally full of, or containing still more formulas may be of intrinsic value, may mark a step forward in the advancement of engineering knowledge. Shall we then reject it because of its necessary ingredient of formulas or because it looks to a person who does not read it, like the first described formulatic paper, of little value? As well say that a good paper contains words—but a bad paper is also composed of words: ergo, throw the good with the bad into the waste-paper basket.

That this whole subject may receive the open, full and earnest discussion it seems to deserve, and steps be taken tending towards a direction precisely the opposite of that indicated to me, at least, by the paragraph quoted above, is my sincere wish.

Another member writes: I read with much surprise * * * of the proposition to give preference to such of the papers presented to the Society for publication as should be "most free from tables and formulas and require the least illustrating."

It seems to me that papers should be judged solely by their intrinsic value. One of the principal objects that we, as a society, are endeavoring to accomplish, is to raise the standard of American engineering, and while I can readily see that many papers of slight value when compared with the expense of their publication, may be presented, yet it is difficult for me to conceive of a paper tending to enlarge the domain of engineering science, or to facilitate its practice, that should not contain one or more of these features that are objected to; and therefore to assume freedom from formulas or other expensive features as the standard of excellence or the ruling element of choice, would be, in my opinion, a great mistake.

If we are too poor to publish such papers, and if we have many such papers offered for acceptance, it would seem to me preferable to solicit some extra subscription from the members rather than to suppress such altogether. Or, if an increase of the annual subscription generally throughout the Society should not seem to be desirable, I have no doubt that many members would gladly contribute to the publication of useful information that would tend to advance their several specialties. It might be worthy of consideration whether a fund might not be established solely to provide for extraordinary expenses in printing.

I hope that this matter, upon which depends largely the future success of our Society, will receive most careful attention before it is decided.

SQUIRE WHIPPLE, in reply to an invitation to be present at the late Annual Dinner of the Society, writes:—

It would certainly be very gratifying to me, to once more press with my feeble grasp the stalwart hands which are so industriously engaged in deep-tilling and subsoiling the fields of which I have so long been endeavoring to grub out some of the weeds, and plant a few seeds on the surface.

In some of the departments of practical engineering, the age of iron has to a large extent superseded the age of wood, and now the age of steel seems destined largely and speedily to take the place of that of iron in its more simple forms, whereby greatly increased service will be obtained with a reduced amount of material, and perhaps also of expense. It is gratifying to witness the progress being made in the work undertaken by the Society in connection with the United States government, in the way of thorough tests and investigations as to the strength and qualities of iron and steel, and the results of different combinations and modes of manufacture. Most valuable results from the

enterprise can hardly ail to be realized. The Society is also doing much excellent work in many other directions, which I need not particularize.

As for myself, my career of humble activity has nearly run out. Younger and stronger hands must do the work and reap the fruits; while it is still my privilege for a short season to occupy the position of an interested looker on.

A CALIFORNIA MEMBER enquires: Is it proper to suggest the adoption of a rule making Life Members, and paying a fixed sum in lieu of annual dues, which are annoying to many members living far distant from headquarters?

I like the proposition for a Mutual Benefit Society if properly managed, but is not the time for default (60 days) too short for distant members who may be cut off without intent. Some of my assistants are out of reach of mail facilities that length of time frequently.

The following from William P. Shinn were presented at the meeting, January 5th:

CONCERNING CONVENTIONS.—Discussion of the enquiry and suggestions of J. James R. Croes in regard to appointment of a chairman —not an officer of the Society—to preside at its Annual Convention.

Mr. Croes ask, "Why should a full set of officers be elected, &c.," but I apprehend that this is not his query, but rather, why should the officers, so elected, be set aside and a chairman be elected to preside at the largest business meeting?

This inquiry naturally suggests another, viz.: why should the "twenty-fifth extra business meeting" be held at a different place from the "twenty-four business meetings" over which the elected officers preside, or in other words—"why have Annual Conventions at points distant from New York?"

1. I believe it will scarcely be questioned that the plan of having a Convention each year, for professional discussion, social intercourse and enjoyment of local excursions, has proved to be one of the best features of the Society, and that it has added to its standing membership and influence for good.

2. These meetings are unlike ordinary business meetings, being more like mass conventions, or "committees of the whole" for discussion of subjects unfettered by the routine of parliamentary rules, such as that prohibiting discussion unless a motion is before the meeting, and objecting to any discussion not bearing upon the pending motion. The "committee of the whole" in a legislative body, is always presided over by a member not an officer, and conventions of all bodies with which I am acquainted, invariably choose their own chairmen.

3. In the election of officers of the Society, the choice is necessarily limited to Resident Members, who alone can be depended upon or expected to attend the semi-monthly meetings. It does not seem unreasonable that the non-resident members should be allowed the privilege, once in each year, of presenting one of their own number, to preside over their *discussions*, particularly when, as soon as they come to deliberation and action, they are in a "regular meeting" and presided over by the duly elected officers of the Society.

4. It does not seem necessary that the person chosen chairman of the Convention should be "not familiar with the action of "the Board of Direction and the business in "hand for the rest of the year," in view of the fact that the Proceedings of the Board of Direction are printed each month in Transactions, and that the business to come before the Convention is fully digested by a Committee of the Board and set before each member by circular, in full time to be understood before the meeting of the Convention.

Mr. Croes probably exaggerated when he referred to it as "the most unwise thing that could possibly be done." I would regard it as far more unwise to depart from a usage which has been attended by so great prosperity to the Society.

CIVIL ENGINEERS' INSURANCE LEAGUE.—In transmitting my reply to the circular of December 2d, declining to become a member of this League, I have thought it proper to state my reasons, differing in opinion, as I do, with the Committee, both as to the expediency and the practicability of the proposed method of making provision for the wants of the families of deceased engineers, while I am wholly in sympathy with the object to be attained.

The plan proposed must be considered in the light of—1st; a *charity*—making provision for meeting pecuniary distress in a time of peculiar need—or 2d; a *business proposition*, for making a wise investment, from which a reasonably certain return may be looked for, when wanted or needed most.

Looked at in either of these lights, I think it fails to fulfill the conditions of success.

1st. As a charity.

A. The first condition of a charity is, that contributions shall be from those who have some surplus which they can spare without distress, to be donated to those who are in

need or want, and the contributions should be in proportion to the means, and the donations should be graduated to the needs.

It is needless to point out that this plan has no such basis, as contributions are equal without regard to means, and the provision is uniform without respect to needs. The family of a deceased millionaire (if such an anomaly exists among engineers), would be entitled to the same fund as would the family of the neediest deceased member.

B. The very condition which drops from the roll any member failing within sixty days to pay his $5 assessment, precludes any idea of charity; as his failure may be from real poverty, after having made his contributions for years, to an amount equal to half (or more) of the decedent fund—he may be sick himself, with a sickness from which he may not recover—his own death may be the next, and for want of payment of one $5, his family may be deprived of their needed aid, after he has done all he can to aid others.

But it will probably be said that no charity was intended—that engineers' families are not to be considered, or not to be allowed to become objects of charity.

In that case, and as I really suppose the Committee intended, the subject it to be discussed in the cold gray light of—

2d. A business proposition.

The first proceeding on the part of engineers, in considering any matter of business, is, or should be, to collect the available data, examine them with reference to their correctness and application to the subject, and then proceed to make the application and deduce results, which should stand the tests of reason and recorded experience.

C. The committee give us as data:—

1. The New York Board of Brokers, 1 060 members; deaths per year, 12; necessary average *life* of a New York *broker*, 88.3 years; and as a person cannot become a member until at least 21 years of age, therefore the average age of the members would be (at their death) at least 109.3 years.

The explanation in this case, is, that men generally do not remain members of the Board of Brokers until they die, they fail in business, or retire from business and sell their membership; or becoming needy, they sell it to realize its value, which is considerable; their places are taken by young men, and the average death rate is kept down by a process and to an extent not at all applicable to our Society.

2. The Police Mutual Benefit Society, number of members, 141; deaths in 2.5 years, 7; average life *as members*, 50.3 years; as youngest members are probably 25, the average at death would be about 75. This society if restricted to active policemen (which fact is not stated), would be constantly recruited with young and healthy men, and as constantly relieved of its old and infirm members. It can scarcely be considered a criterion for the operations of the proposed Insurance League.

3. The Clergymen's Mutual Insurance League; members in 5th, 6th and 7th years respectively, 1 029, 1 052 and 1 049; deaths 13, 19 and 18; average membership during the three years, 1 043.3; average deaths during the three years, 16.7; average life of members as such, 61.6 years. As they must have averaged at least 30 years of age at joining, the average life of the persons would be 91.6 years, to make these figures applicable.

4. The American Society of Civil Engineers.

	1873.	1874.	1875.
Members in past 3 years..	315	361	403
Deaths reported " ..	3	5	8
Proportion of deaths to members; one to..... .	105.	72.2	50.4

Average membership for three years, 359.7; average deaths for three years, 5.3; average life of members as such, 67.4. As the average age of the members of the Society in 1873, was probably not below 40, we would have as the average life of the persons, deduced from these data, about 107 years.

It can only be said that the last named societies have not been organized long enough to attain their *average* death rate.

If the Committee knew and recognized this fact, why was it not mentioned, and followed to its conclusion? For what purpose were the figures quoted, if not as data from which members might calculate the *probable* demand upon their funds, in case they joined the proposed League. Are not these figures simply deceptive, and my reasoning from them of necessity fallacious? Let us discuss this as—

D. Assuming the average of ages of the Society's members in 1873 to have been 40 years, which is probably not *above* the true average. The only authority which I happen to have at hand—a pamphlet of the Equitable Life Assurance Society, issued in 1860—places the average expectation of life at the age of 40 at 27.28 years, and at 45 at 23.69 years, so that the more probable average life of members from this time would be about 25 years.

Upon this basis the average death rate in the Society would be 16.12 per annum of 403 members, or 14.36 per annum out of the 3 years average of 359.7; instead of 5.3 per annum, the average of 3 years.

This average would be 4 deaths per annum for each 100 members, and would compare with the data given as follows;

	Numbers.	Deaths per Annum.	Average on above basis.	Ratio.
N. Y. Board of Brokers.....	1 060	12.	42.4	3.53
Police Mutual Benefit Society.....	141	2.8	5.64	2.02
Clergyman's Mutual Insurance League.....	1 043	16.7	41.72	2.5
American Society of C. E's.....	360	5.3	14.4	2.7
Total....	2 604	36.8	104.16	2.83

Whence it would appear that the average of the committee's data bears to the probable facts, the ratio of 1 to 2.83.

E. The only possibility of success in such an organization as proposed, lies in its *perpetuity.* If its membership is not constantly strengthened by new and young members, the death rate increases, one after another declines to pay, or is unable, and the organization dies of atrophy.

Suppose 100 members join, one dies—the 99 remaining pay $5 each—$495; a second dies and the 98 remaining pay $5 each—$490; if no accessions are had, and all of the 100 fulfill their agreement, what is the result with the one-hundredth? He has paid out $5 × 99 = $495, and gets 0.

This is certainly the "Reductio ad absurdum," but it is the only final result, unless the League is continued *forever!*

F. That cannot possibly be a successful business enterprise which can never be wound up, so as to give the parties interested, value for what they have put in. In this case, any winding up, means abandonment of all that has been invested, as the only chance of return rests upon the future payments of others, and the past contributions have created no fund from which payments can be made.

G. Prudent provision for the accidents and infirmities of age should be made in such way that the demands upon persons decrease with advancing years. Under this plan, as the members become older, the death rate increases, and the consequent payments become more frequent, as the ability to pay decreases.

H. Finally, the terms offered by our best life assurance companies, present a greater certainty with less expense, than the mutual plan recommended by the Committee.

The authority before referred to, gives as the annual premium to be paid during life on $1,000 commencing at the age of 43 (the age at which the expectancy of life is 25 years as assumed above)—$35.46; and the premium to be paid annually *until the age of* 60 (and then to cease), at $46.11 per annum, while on the assumed average life of 25 years, with 200 members (the number required to make $1,000 payment at death), the average deaths would be 8 per annum, and the average annual payments would be $40 per annum, and it would continue during life, commencing with about $20 per annum, and reaching $60 per annum before the death of those who realize the average of life.

If a life assurance organization is desirable in connection with the Society, it can be much better provided for by arrangement with three or four life assurance companies to take the risks on their best terms, with agents' commissions off.

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

Algebra for Schools. Part I. Definitions, simple Rules, elementary Formulæ, and easy, simple Equations. George Porter. Belfast. 12mo. *Mullan.* 6d.

——, the Scholar's—an introductory Work; Lewis Hensley. London. 8vo. *Macmillan.* (*New York.*) 4s. 6d.

Archæological Sketches in Scotland; Knapdale and Gigha. T. P. White. Folio. *Blackwood.* 42s.

Archæology of Rome. Part 4; the Egyptian Obelisks, to which is added a Supplement to the first three Parts, which form the first Volume. John Henry Parker. London. 8vo. *Parker.* 10s. 6d.

Architecture; Windsor Castle, picturesque and descriptive—23 Photographs. B. P. Woodward. London. Folio, illus. *Ward & Lock.* 105s.

Botany; Plant Analysis, for Schools, Colleges, and the independent botanical Student; Mark W. Harrington. Ann Arbor. *Sheehan & Co.* (Announcement.)

Bridges; a Comparison of the various Forms of Girder Bridges, showing the Advantage of the "Schwedler" Bridge; a Paper read at the Institution of Civil Engineers, by W. Beswich Myers. London. 8vo, illus. *Spons.* (*New York.*)

Centennial Exhibition and Philadelphia Visitor's Guide. Philadelphia. 12mo, illus. *Lippencott & Co.* $0.50.

Church Builder—for 1873. London. *Rivingtons.* 1s. 6d.

Civil Engineers; Minutes of Proceedings of the Institution of—— ——with other selected and abstracted Papers. Vol. XLII. Sessions 1874-5. Part IV, ed. by James Forrest. London. 8vo, illus.

Coal-Mining. Mining Engineering, a practical Treatise on Coal-Mining. George G. Andre. Part 9. London. 4to. illus. *Spons (New York.)* $2.00

—— —— Principles of —— —— J. H. Collins. (Elementary Science Series), New York. 16mo, illus. *Putnams.* $0.75.

Commerce, a Dictionary, practical, theoretical and historical, of Commerce and commercial Navigation; J. R. McCulloch, with a biographical Notice by the Editor; new ed. rev. and cor., a Supplement being added to show the Progress of commercial Legislation down to the present Time. Ed. by Hugh G. Reid. London. 8vo. *Longmans.* 63s.

Cyclopedia, the American —— a popular Dictionary of general Knowledge. Ed. by George Ripley and Charles A. Dana. Vol. XIV. Prior—Shoe. New York. 8vo, illus. *Appletons.* $5.00.

Drawing. Philip's Landscape drawing Studies. Philips. Fol. packet. London. *Philips.* 1s.

—— Books; the national School Board Series. in 12 parts. Designed by Robert Brydall. London. *Cameron & Ferguson.* 12d.

Engineers: Information for colonial ——Ed. by J. T. Hurst. Vol. I., Ceylon, by A. Deane. London. 8vo, illus. *Spons.* (*New York.*) 2s. 6d.

Encyclopædia Britannica. 9th ed. Vol. 3. Edinburgh. 4to, illus. *Black.* 30s.

Functions; an elementary Treatise on Laplace's, Lamé's and Bessel's Functions. I. Todhunter. London. 8vo. *Macmillan.* (*New York.*)

Geological Sketches. L. Agassiz. 2d series. Boston. 16mo, illus. *Osgood.* $1.75.

Geometry and Mensuration for Schools. Part 2. Second Book of Euclid and Mensuration of Circle, Zone, Ellipse and Surfaces of Solids. W. G. Browne. Belfast. 12mo. *Mullan.* 6d.

—— —— Elements of —— based on Euclid, Books 1-3, for elementary and middle class Schools. Edward Atkins. 12mo. London. *Collins.* 1s. 6d.

Heat; Numerical Examples in —— with Answers. R. E. Day. London. 8vo. *Longmans.* 1s. 6d.

Hydraulics, a descriptive and historical Account of Hydraulic and other Machines. Thomas Ewbank. New ed., rev. New York. 8vo. *Scribner.* $5.00.

Insects. Guide to the Study of —— and a Treatise on those injurious and beneficial to Crops. A. S. Packard, Jr. 5th ed. New York. 8vo, illus. *H. Holt & Co.* (Announcement.)

Iron Analysis Record, for Blast-Furnaces and Rolling-Mills. Troy. 12mo. *W. H. Young.* $1.00.

Ivories, ancient and mediæval. Wm. Maskell. London. 12mo. illus. (*Van Nostrand.*) *New York.* $1.25.

Mechanical Laboratory; on the Necessity of —— its Province and Methods. Robert H. Thurston. Philadelphia. 8vo. *Franklin Institute.*

Mining Engineers. Address of the President, Alexander L. Holley, before the Institute of —— —— at the Cleveland Meeting, October 26th, 1875. Philadelphia. 8vo.

Musical Instruments, Carl Engel. London. 12mo, illus. (*Van Nostrand, New York.*) $1.25.

Natural History; Contributions to —— —— and Papers on other Subjects. James Simson. Edinburgh. 8vo. *Houlston.* 6s.

Patent Cases determined by the Supreme Court of the U. S., including Copyright and Trade-Mark Cases, and a Table of all American Patent, Copyright, and Trade-Mark Cases which have been cited, affirmed, or reversed. Charles Sydney Whitman. Washington. 8vo. *Morrison.* $10.00.

—— Specifications and Drawings of —— issued from the U. S. Patent Office for July, 1875. Washington. 8vo, illus.

Philosophy; analytical Processes, or the primary Principal of Philosophy. William I. Gill. (3d vol. of the International Prize Series.) New York. 12mo. *Author's Publishing Co.* $2.00.

Philitus; or Solution of the Mystery which for 4,000 years has shrouded the great Pyramid in Egypt. Charles Casey. 3d ed., rev. and enl. Dublin. 8vo. *Carson.* 2s.

Railway Accidents; Returns, July to September, 1875. (Parliamentary Report.) London. 8vo. 1s. 2d.

—— Inspector's Reports. Part 6. June to August, 1875. (Parliamentary Report.) London. 8vo. 2s 8d.

—— System. Jubilee Memorial of —— —— History of the Stockton and Darlington Railway. J. S. Jeans. London. 8vo. *Longmans.* 7s. 6d.

Sanitary Commission. 2d Report. Vol. 3. Part 2. (Parliamentary Report.) London. 8vo. 2s.

Sewage. Reports to the Nottingham and Leen Valley Sewage Board, &c. T. O. Tarbottin. London. 8vo. *Spons.* (*New York.*) 2s. 6d.

Steam Boiler Explosions. Records of —— E. B. Marten. London. 8vo. *Spons.* (*New York.*) 5s.

—— Engines, Pocket Book of practical Rules for the Proportions of modern Engines and Boilers for Land and marine Purposes. N. P. Berg. 5th ed. London. 32mo. *Spons.* (*New York.*) 4s. 6d.

—— metric and English Table of Temperatures and Pressures of saturated Steam, from Experiments made at the Paris Observatory by M. Regnault, calculated for practical Purposes and including atmospheric Pressure, by R. A. Peacock. London; sheet. *Spons.* (*New York.*) $0.20.

Studies. Remarks on the Cambridge mathematical Studies and their Relation to modern physical Science. James Challis, Cambridge. 8vo. (*Van Nostrand, New York.*) $1.75.

—— the true Order of Studies. Thomas Hill. New York. 12mo. *Putnam.* $1.25.

Telegraph Engineers. Journal of the Society of —— —— including original Communications on Telegraphy and electrical Science, ed. by Frank Bolton and George E. Preece. Part 10. London. 8vo, illus. *Spons.* (*New York.*) $2.00.

Trigonometry, &c.; progressive Lessons in applied Science. Part 3. Trigonometry, Vision, Surveying Instruments. E. Sang. London. 8vo, illus. *Spons.* (*New York.*) $1.25.

Wages and the Wages Class. Francis A. Walker. New York. *H. Holt & Co.* (Announcement.)

ADDITIONS TO

LIBRARY AND MUSEUM.

DONATIONS ARE ACKNOWLEDGED AS FOLLOWS:

From G. W. R. Bayley, New Orleans:
Address to the Public by Louisiana Levee Company, John Henderson, President. New Orleans, 1875. 2 copies.

From Frederick Brooks, L. Frederick Rice and Clemens Herschel, Committee, Boston, Mass.:
Metric System of Weights and Measures. (A copy for each member.)

From Charles O. Brown, Paterson, N.J.:
Five Photographs of New Portage Bridge.

From the Editors and Publishers, New York:
The American Cyclopedia, Vol. XIV. Prior to Shoe. 1875.

From Charles H. Fisher, Albany, N. Y.:
Photograph of Mohawk River—and one of Johnson's Creek Bridge, New York Central R. R. (Framed.)

From George S. Greene, Jr., New York:
Proposals—Department of Docks—for furnishing Portland Cement and for building a wooden Pier (new Pier 42, N. R.) 2 numbers.

From George E. Harding, New York:
Projected Bridge over East River, from New York to Long Island City. Water-color—framed.

From Alexander L. Holley, New York:
Address of the President before the American Institute of Mining Engineers, Cleveland Meeting, October 26th, 1875. Philadelphia. (Copies for distribution.)

From Hoopes & Townsend, Philadelphia:
Specimens of Iron, cold punched (3 pieces).

From Gen. A. A. Humphreys, Chief of Engineers, U. S. A., Washington, D.C.
Reports to the Chief of Engineers, embodied in his Report to the Secretary of War, for Year ending June 30th, 1875, as follows: (2 copies each.)
Of Board of Engineers, and Correspondence relating to Improvement of Mouth of the Mississippi River by Jetties.
On Bridging navigable Waters of the U. S.
Of Commission of Engineers upon Reclamation of alluvial Basin of the Mississippi River.
Compilation of Map of Territory of U. S. west of the Mississippi, with a geographical Memoir. G. K. Warren.
On compressive Strength, specific Gravity and Ratio of Absorption of Building-Stones in the U. S., in most general Use. Q. A. Gillmore.
On Enlargement of Saint Mary's Falls Canal and Improvement of St. Mary's River; Harbors and Rivers on Lake Huron and Saint Clair; Saint Clair Flats Canal, and of Detroit River. G. Weitzel.
On Explorations and Surveys in the Department of the Missouri, E. H. Ruffner and G. L. Gillespie;—of the Platte, W. S. Stanton;—and of the Pacific, J. C. Mallery.
On Geological Exploration of 40th Parallel, from Sierra Nevada to eastern Slope of Rocky Mountains, Clarence King.
On Improvement and Care of public Buildings and Grounds in District of Columbia, and on the Washington Aqueduct, O. E. Babcock.
On Improvement of the Harbors—of Chicago, Calumet, Michigan City and New Buffalo, Lake Michigan, G. L. Gillespie;—of Lake Erie, C. E. Blunt;—of Lake Michigan, Eastern Shore, S. M. Mansfield;—of Lake Ontario and River St. Lawrence, John M. Wilson;—of Lake Superior (except Duluth and Superior City), and on Green Bay and the Western Shore of Lake Michigan, north of Milwaukee, Wisconsin, H. M. Robert;—on Long Island Sound, J. W. Barlow;—of Milwaukee, Racine, and Kenosha, Lake Michigan, Improvement of the Fox and Wisconsin Rivers and Harbors, D. C. Houston;—of Superior City and Bay, and Duluth, Lake Superior, F. U. Farquhar.
On Improvement of Rivers and Harbors in Alabama and Florida, A. N. Damrell;—in California, G. H. Mendall and C. Seaforth Stewart;—in Connecticut and Rhode Island and part of Massachusetts, G. K. Warren;—in District of Columbia, Virginia and North Carolina, S. T. Abert;—in Maine, New Hampshire and Massachusetts, George Thorn;—in Maryland, Virginia, West Virginia and North Carolina, W. P Craighill;—in New Jersey, Pennsylvania and Delaware, J. D. Kurtz;—in New York and New Jersey, John Newton;—on the Coast of South Carolina, Georgia and the Atlantic Coast of Florida, Q. A. Gillmore;—on the Mississippi, Missouri, Arkansas, White and St. Francis Rivers, C. R. Suter;—on the Mississippi River between Mouths of the Illinois and the Ohio, and of the Osage River, Missouri, J. H. Simpson;—of Mouths of Mississippi River and of Rivers and Harbors in Louisiana and Texas, C. W. Howell;—of Navigation at Falls of Ohio River and the Superintendence and Management of Louisville & Portland Canal, G. Weitzel;—of the Ohio, Monongahela and Wabash Rivers, W. E. Merrill;—of the Ouachita and Yazoo Rivers, Removal of Red River Raft, Improvement of Tone's and Cypress Bayous, and Construction of Dam at Foot of Sodo Lake, also Water Gauges on the Mississippi and its Tributaries, W. H. H. Benyard;—of Rivers in Oregon and Washington Territory, N. Michler;—of the Tennessee and Cumberland Rivers, the Tombigbee River within Mississippi, and the Oostenaula and Coosawattee Rivers, Georgia, Walter McFarland;—and of the upper Mississippi River, between St. Paul and Grafton, the Des Moines and Rock Island

Rapids of Mississippi River and the Illinois River, J. N. Macomb.

Memoranda relating to Improvement of the Entrance to Mississippi River by Jetties, A. A. Humphreys.

Preservation of the Falls of Saint Anthony and Improvement of the Mississippi River above the Falls, Construction of Lock and Dam at Meeker's Island, Minnesota River, F. U. Farquhar.

And on Transportion Routes to the Seaboard.

Also separate Proposals and Specifications for the following:

Constructing Breakwater at Sand Beach; Dam on Great Kanawha River; Dyke in Hudson River between New Baltimore and Barren Islands; Ice Harbor Piers, New Castle; Lock on Great Kanawha River; Pier and Protection on Minnesota Point; Pier at Ontonagon Harbor and Wing-Dams on Upper Willamette River.

For Dredging Aquia, Nomini and Otter Creeks; Bridgeport, Crinfield, Duluth, Milford, New Bedford, New Haven, Newport, Ogdensburg, Port Jefferson, Waddington, Wareham and Wilmington Harbors; and Appomattox, Connecticut, Delaware, Elk, Hudson, Junction of Pine and St. Clair, Norwalk, Occoquan, Patapsco, Pawcatuck, Penobscot, Rappahannock, Savannah,, Sebawaing and Taunton Rivers.

Extension of Breakwater in Burlington and Swanton Harbors, and of U. S. Piers at Grand River Harbor and in Rocy River.

Iron for Landing Pier near Lewis, Delaware.

For Improvement of Boston, Bridgeport, Black Lake, Calumet, Camden, Charlotte, Cedar Keys, Chicago, Fall River, Frankfort, Hingham, Ludwigton, Manistee, Michigan City, Milford, Milwaukee, Mobile, Muskeyon, New Haven, Oak Orchard, Plymouth, Pultneyville, Saugatuck, Great Sodus, Little Sodus, South Haven, St. Joseph, Washington and Georgetown, White River and Wilson Harbors;—of the Appomattox, Cape Fear, Cocheco, Delaware, Elizabeth, Elk, Fox, Great Kanawha, Illinois, James, Kennebec, Machias, Merrimac, Mississippi, Nans mond, Norwalk, Ohio, Penobscot, Sacramento and Feather, Schuylkill, Tennessee and Wabash Rivers;—of Rivers and Harbors at Ashtabula, Black River, Buffalo, Dunkirk, Monroe, Sandusky City, Toledo and Vermillion;—of Sabine Pass, of Ship Channel between the mouth of the San Jacinto River and Bolivar Channel, and the Red Fish Bar in Galveston Bay, of St. Mary's Falls Canal and of Washington Aqueduct.

For Machinery, Joiner Work and Painting; for Pile, Revetment and Dredging at Saginaw River; for Removal of Fast Rock in Christiana River—of Snags, &c., from the Minnesota River, and of Wrecks from Ohio River; for Sand for Water Battery at Fort McHenry; for Stone for Port Jefferson, Southport and Stonington Harbors, and Richmond's Island, and for Stone Work and Dredging at Oakland Harbor, and for U. S. Breakwater at Cleveland.

From the Institution of Civil Engineers, London, England:

Minutes and Proceedings—with other selected and abstracted Papers. Vol. XLII. Session 1874-75. Part IV. London. 1875.

From the Institution of Mechanical Engineers, Birmingham, Eng.:

Proceedings, July, 1875. Manchester Meeting. Part II. Birmingham.

From L. Katzenstein & Co., New York:

Specimen of Patent self-acting Metal Packing.

From Robert A. Morris, Nashville, Tenn.:

Annual Report of Nashville, Chattanooga & St. Louis Ry. September 15th, 1875. Nashville. (2 copies.)

From Charles Paine, Cleveland, O.:

Passenger Ticket of Mohawk & Hudson R. R. Albany to Schenectady, an (early specimen).

From C. P. Sandberg, London, Eng.:

Strength of Rail Joints, a Paper read before the Iron and Steel Institute. November 25th, 1875. By C. P. Sandberg. London.

From John Wiley & Sons, New York:

Elements of graphical Statics and their Application to framed Structures. A. Jay Du Bois. 2 vols. New York. 1875.

ANNOUNCEMENTS.

MEETINGS: The next *stated* meeting of the Board of Direction will be held Wednesday, February 2d, at 3 o'clock P. M., for the transaction of regular business.

The next *regular* meeting of the Society will be held Wednesday, February 2d, at 8 o'clock P. M., when ballots for members will be canvassed; the amendment to the By-Laws recommended by the Board of Direction, acted on, and other matters considered.

The next *stated* meeting of the Society will be held Wednesday, February 16th, at 8 o'clock P. M., when a paper upon "The Practical Determination of Strains in the braced Arch," by Prof. A. J. Du Bois of Bethlehem, Pa., will be read and other matters of interest taken up; after the formal session an hour will be given to conversation.

THE CENTENNIAL COMMISSION of the Society meets on Wednesday evening, at 8 o'clock, except when a meeting of the Society is held on the same evening—and then—immediately after the Society adjourns.

A LIST OF CONTENTS for Volume IV of Transactions are issued herewith; one for Volume I of Proceedings will appear next month.

LIST OF MEMBERS.

ADDITIONS.

BENYAURD, WILLIAM H. H....Major of Engineers U. S. A., Memphis, Tenn. December 8, 1875.
MORLEY, ISAAC.....Civil Eng. Water Extension, Pittsburgh, Pa. " 15, "
SEARS, CLINTON B.....Lieut. of Engineers U. S. A., Boston, Mass. January 15, 1876.
WORTHINGTON, HENRY R.....239 Broadway, New York. " 11, "

CHANGES AND CORRECTIONS.

BURR, WILLIAM H., ...Room 40, Hall Building, Troy, N. Y.
COURTRIGHT, MILTON .....New York Elevated R.R., 7 Broadway, New York.
CRAVEN, ALFRED W.....26 West 18th St., New York.
EMERSON, GEORGE D.....Prof. Eng., Missouri School of Mines, Rolla, Mo.
HILL, JOHN W.....Niles Tool Works, Hamilton, O.
KENNEDY, WILLIAM H.....29 Ninth St., Pittsburgh, Pa.
MACRITCHIE, CHARLES.....Milwaukee, Wis.
MCALPINE, WILLIAM J.....20 Elk St., Albany, N. Y.
MCCLELLAN, GEORGE B.....Baltimore, Md.
MORRIS, MARSHALL.....150 Main St.,Louisville, Ky.
MICHAELIS, OTHO E.....Captain Ordnance Corps, U. S. A., St. Paul, Minn.
MORISON, GEORGE S.....38 East 20th St., New York.
NORMAN, GEORGE H .....343 Bacon St., Boston, Mass.
ST. JOHN, I. M.....Consulting Eng. C. & O. R.R., Richmond, Va.
STAHLBERG, ALBERT J.....Los Angelos, Cal.
STAUFFER, DAVID MCN.....127 South 13th St., Philadelphia, Pa.
THOMPSON, JOHN C.....Ass't Eng. Dept. Public Works, New York.
WARD, CHARLES D.....39 Hudson St., Jersey City, N. J.
WARD, JOHN F.....133 Mercer St., Jersey City, N. J.
WARD, LEBBEUS B.....39 Hudson St., Jersey City, N. J.

DECEASED.

ASPINWALL, WILLIAM H. [F.]..Late of New York. January 18, 1875.

American Society of Civil Engineers.

PROCEEDINGS.

Vol. II, February, 1876.

MINUTES OF MEETINGS.

(Abstract of such as may be of general interest to members.)

OF THE SOCIETY.

FEBRUARY 2D, 1876.—A regular meeting was held at 8 o'clock P.M.

The vote on admissions to membership was canvassed and the following declared elected :—Members, Messrs. Stacy B. Opdyke of Philadelphia, Pa., Julius H. Streidinger of New York and William A. Sweet of Syracuse, N. Y. ; and Juniors, Henry St. L. Copée and Caspar W. Haines of Philadelphia, Pa. and Albert B. Hill of New Haven, Conn.

It was announced that Alexander J. Cassatt, Sidney T. Fuller, Jacob H. Linville, Joseph D. Potts, Henry Pettit, Samuel J. Reeves, Fairman Rogers, Samuel L. Smedley and Joseph M. Wilson were appointed additional members, resident in Philadelphia, of Committee on Eighth Annual Convention.

The amendment to the By-Laws recommended by the Board of Direction, December 1st, to the Society for adoption, and then amended, and made the order at this meeting, was considered, clause by clause, and adopted ; it is as follows :

Addition to SECTION 1. A Convention of the Society for professional discussion and social intercourse shall be held annually, at such place as the Society may determine, and be presided over by a chairman selected from among Members not officers of the Society. During the Convention, a regular meeting of the Society, to be presided over by the officers of the Society, may be held for the transaction of business.

The officers of the Society may give a reception at the Society's rooms on the evening of the second and fourth Wednesday of each month between October and April, for the purpose of informal professional conversation and social intercourse. Regulations concerning refreshments and the invitation of guests may be made by a committee appointed for the purpose, but shall be without expense to the Society.

A paper, by Benjamin S. Church, C. E., of New York—"Notes and Suggestions on the Croton Water Works and Supply for the Future"—was read and discussed, and further consideration was made the special order for meeting on April 5th.

FEBRUARY 16TH, 1876.—A stated meeting of the Society was held at 8 o'clock P. M.

Attention was called to a Bill to establish a "Bureau of Architecture in the Treasury Department," prepared by the Board of Trustees of the American Institute of Architects, and introduced in the House of Representatives, February 7th, and a letter* was read from Frederick Brooks, of Boston, Mass., dated January 20th, referring to the communication† on the "System of Metric Weights and Measures," recently addressed to members of the Society.

A paper upon "The practical Determination of the Strains in the braced Arch," by Prof. A. Jay Du Bois of Bethlehem, Pa., was read, and discussion followed, which is to be resumed after the paper is printed; due notice of which, is to be given.

The deaths—on January 18th, 1875, of William H. Aspinwall, Fellow from July 9th, 1870; and on February 15th, of William Y. Arthur, Member from January 2d, 1868, and Fellow from September 20th, 1870, were announced, and it was moved that for each a committee be appointed to present to the Society a fit memoir of the deceased. Brief remarks were made, referring to Mr. Arthur's membership and his contributions to the library, and the following was adopted:—

Resolved, that the members of this Society learn with profound sorrow of the death of one of its earliest and most honored members; while uniting with his family in mourning for their bereavement, we deeply feel the loss to the Society of personal effort and effective contributions which have characterized his connection with it.

OF THE BOARD OF DIRECTION.

FEBRUARY 2D, 1876.—A stated meeting was held at 3 o'clock P. M.

The Treasurer's report for the past month was presented, proposals for admission to the Society were considered, and other matters taken up; the Board adjourned for one week.

FEBRUARY 9TH, 1876.—An adjourned meeting was held at 3 o'clock P. M. Appropriations for the current month were made, and other routine business done.

A statement relating to arrearages and delinquent members was presented, and after consideration it was resolved that Transactions be not sent to members who are more than one year in arrears, that copies for such members be specially reserved for issue when the arrearages are

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* Page 31. † Issued with December Proceedings.

paid, and that due notice of this action be sent to each delinquent. The Treasurer was requested to recommend to the Board what steps should be taken under this resolution.

A communication from the Franklin Institute (of Philadelphia) tendering to the Society, use of the rooms and lecture hall of the Institute on June 13th, 14th and 15th, for the purposes of the Eighth Annual Convention, was read, and the invitation duly accepted with thanks.

Messrs. Holley, Bogart and Chanute were constituted a committee under clause of the By-Law adopted February 2d (Addition to Section 1), prescribing that regulations concerning refreshments at the Officers' Receptions and the invitation of guests may be made by a committee appointed for the purpose.

Mr. Holley offered a preamble and resolution relating to the work of the "United States Board for Testing Iron, Steel and other Metals," which were adopted, ordered to be printed, and a copy sent to each member of the Society, with the request that so far as lies in his power, it be brought to the attention of Members of Congress.

STATEMENT OF THE

FINANCES OF THE SOCIETY,

PREPARED FROM THE TREASURERS' REPORTS.

RECEIPTS, 1874-5.

Past dues from 6 resident Members	$225 00		
" 13 non-resident "	285 00		
" 1 " Associate	10 00		
		$520 00	
Current Dues from 87 resident Members	$2 175 00		
" 219 non-resident "	3 345 00		
" 4 resident Associates			
" 9 non-resident "	330 00		
" 24 Juniors			
		5 850 00	
Half Dues from 2 resident Members	$25 00		
" 9 non-resident "	67 50		
" 1 " Associate	55 00		
" 10 Juniors			
		147 50	
Entrance Fees from 24 Members	$720 00		
" 3 Associates	620 00		
" 28 Juniors			
		1 340 00	
			$7 857 50
Interest on Norman Medal Fund		$70 00	
Advertisements in Transactions		604 67	
Publications and Miscellaneous		233 06	
			907 73
Treasurer's Receipts for year ending November 1st, 1875			$8 765 23
" Balance, November 1st, 1874			838 92
Total			$9 604 15

PAYMENTS, 1874–5.

Printing, Illustrating and Copyright	$3 112 77	
Stationery and Circulars	487 37	
Postage and Revenue Stamps	320 66	
Library	20 90	
Rent, Fuel and Janitor	1 178 40	
Furniture and Removal	551 79	
Secretary and Clerks	3 000 00	
Insurance	42 08	
Norman Medal	76 45	
Engraving and Printing Diplomas	427 50	
Sundries	110 60	
Treasurer's Payments for Year ending November 1st, 1875		$9 328 52
" Balance, November 1st, 1875		$275 63

ASSETS AND RESOURCES, NOVEMBER 1ST, 1875.

Furniture, Library and Transactions on hand, (Secretary's estimate).		$7 500 00	
McAlpine Library, (insured for)		2 000 00	
			$9 500 00
Fellowship Fund: 8 Jersey City Water Loan (7%) Bonds, par value $8 000—cost	$8 250 00		
Accrued Interest, from July 1st	186 67		
1 U. S. Registered (5-20, 6% gold) Bond, par value $500—cost	579 38		
Balance uninvested	6 12		
		$9 022 17	
Normal Medal Fund*: 1 New York City Croton Aqueduct (7%) Bond	$1 000 00		
Accrued Interest, one year	70 00		
		1 070 00	
Deposit in "Seaman's Savings Bank for Savings"	$764 17		
Accrued interest, from July 1st (estimated)	15 28		
		779 45	
New York Central Railroad Stock*: 5 shares—cost		536 25	
Treasurer's Balance, November 1st, 1875		275 63	
			11 683 50
Members' past Dues		$2 145 00	
" current Dues (payable November 3d)		7 225 00	
			9 370 00
Total*			$30 553 50

RECEIPTS AND PAYMENTS FOR QUARTER ENDING JANUARY 31ST, 1876.

	Receipts.		Payments.	
In November	$1 639 75	.....	$775 15	
" December	1 232 97	.....	848 60	
" January	1 465 11	.....	593 61	
	$4 337 83	.....	$2 217 36	
Excess of Receipts				$2 120 47
Balance at Beginning of Quarter				275 63
" End "				$2 396 10

* The value of dies for the Norman Medal, and dividends on the New York Central Railroad Stock accrued since April 2d, 1868, are not included.

NOTES AND MEMORANDA.

THE CENTENNIAL COMMISSION OF THE SOCIETY.*

During the last month, encouraging progress has been made in the work undertaken by the Commission. Contributions of important drawings and records referring to early engineering operations have been secured; and a large amount of interesting material, illustrating practice in the several branches at the present day, is promised.

The Commission is co-operating with the American Institute of Mining Engineers, which will have rooms in Philadelphia (1123 Girard avenue) open day and evening from March to December, for the use of members of the Institute and other persons, citizens or strangers, properly introduced. The Franklin Institute has also extended the free use during the Exposition, of its Library and Reading Room, to members of this and similar societies duly accredited. This Commission has also extended to members of the engineering associations here and abroad, with which the Society is in communication, an invitation to make its offices either in New York or Philadelphia their headquarters during their visit to the Exposition.

At a recent meeting, it was *resolved;* whereas this Commission has announciated its unwillingness to assume the position of an advertising agency, it does not object to collate, place on file or distribute information that may be generally useful, notwithstanding such action may result in the individual benefit of the exhibitor; therefore, the Chairman of each Sub-committee shall carefully examine all albums, pamphlets or documents that may be submitted to him, with a view to place on file and exhibit conspicuously, only such as convey general useful information, rather than those designed solely for individual advertising.

The cost of the proposed effort of the Commission has been estimated at about $5 000, the Chairmen of the several Sub-committees have been constituted a Board of Finance, to co-operate with the Chairman† of the Sub-committee on Finance, in raising this sum, and circulars asking contributions thereto have been sent to members of the Society.

At the meeting January 19th, Messrs. Holley and Bogart were instructed to embody in a circular a statement of the objects and work of the Commission; from this the following is taken:—

I.—A fine room, 24 x 48 feet, in the Main Exhibition Building has been definitely secured, giving space for an ample office, for a good number of wall drawings, for a large number of drawings in portfolios, and for some models.

It is understood that an additional, though not very large amount of space will be secured, only upon condition that the Society will guarantee to fill it creditably with drawings, models, and machines, illustrating consecutively the progress of American engineering.

It is important that chairmen of sub-committees promptly ascertain what space they require, and report to the Secretary of the Society.

It would seem important to request that dates be written upon all drawings and models, in large figures, and that a brief explanation and historical record be attached to or written upon each.

II.—One of the most comprehensive and useful undertakings of the Commission, and one of the most practicable in the short time at hand, will be the collection and distribution of information about the American engineering objects at large, which will be in the Exhibition and about the works, machinery, &c., which produced them. It is suggested that the chairmen of sub-committees, at once, offer to exhibitors (a list of whom will be at the Society's rooms), the services of the office and secretary of the Commission, not as a means of advertising, but as a means of introduction and intercommunication between exhibitors, visitors, and the profession generally. Foreign engineers, it is believed, will be particularly assisted and pleased by such courtesies. A conspicuous card on the exhibit would refer the interested visitor to the office of the Commission, where he could be directed how to best find works, manufactories and persons, and where he could examine a complete set of engineering albums, and obtain such information as exhibitors might wish to communicate. While this would further the objects of exhibitors, it would place the Society in the attitude of an important factor in the Exhibition, and a professional conservator of engineering interests.

III.—The chairmen of sub-committees on engineering subjects are a committee to procure memoirs from members of the Society, on the state and progress of civil engineering

* Continued from page 6.

† W. Milnor Roberts of New York.

in America, and as illustrated at the Exhibition, and to cause the same to be edited for publication.

By a little extra exertion, much of the matter for these memoirs may, probably, be better obtained from exhibitors now, while their minds are directed to preparations for the Exhibition, than at a later period.

IV.—It is requested that chairmen of sub-committees inform one another of suitable objects for historical exhibition which they may hear of in each other's departments.

Late as the labors of the Commission have begun, the exhibit of drawings and models illustrating progress can be made very complete and creditable if the committees will, at once, begin earnest work. These drawings and models are all in existence; hunting them out and putting them in condition will cost so little time and trouble that few of their possessors will decline to contribute them, if earnestly appealed to. In several departments some very important drawings and models are already promised, and it is hoped that no department will be unrepresented.

The following is from circulars issued by Chairmen of Sub-Committees during the past month.*

On Steam Engineering.†—This exhibition on the part of the Society is not supposed to trench upon the mechanical department of engines, boilers or models in the Hall, but to supplement and illustrate that department, in its general relation to civil engineering, both historically and practically. The application of steam in internal navigation of rivers and canals, in ocean navigation, in locomotion, in construction, dredging, excavating, hoisting, water works and mines, the origin, steps of progress and final point of development of all these, afford great scope for illustration by models, copies of old or new drawings, and by descriptions. Already the possibility of recording much that has been done in steam engineering has passed away. Much, if not most, of the practice of the engineer in the work shop, in use to-day, has never been recorded at all, and above all, its origin has never been asserted or declared; the opportunity at this time given to perpetuate the memory of invention and of skill, must now be accepted or the history be lost. Above all, the isolated practice and individual development of the directing engineer are generally left unnoticed and undescribed.

Upon these grounds the Sub-Committee on Steam-Engineering asks you to furnish such plants, models or descriptions as you may have or be willing to prepare.

It is especially desirable to have models of old engines, locomotives or boilers or machinery, now superseded or improved, and it is recommended to supply photo-lithographs of drawings or tracings. It would be well to make or have made, the photo-lithographs to a uniform size of sheet not over 12 x 10, with a scale drawn on each sheet.

The Sub-Committee would also ask to you communicate this request to any persons who may to your knowledge possess any engineering information desired by the committee, and solicit their contributions.

We want descriptions and illustrations of engines, boilers and work long since gone out of use, of those in use to-day, and of those prospectively valuable. The descriptions should be concise, the statements confined to points of verification, and without allusions to rivals in former or present existence. The purpose of our exposition is to furnish to foreign and American civil engineers, historical and practical information regarding steam engineering.

For the convenience of readers, it is requested that descriptions or writings be made on legal cap or cut foolscap paper, using one side only to write upon.

On Metallurgical Engineering,* No. 1—It is ascertained that farther space will be provided for the American Society of Civil Engineers, if it will guarantee to fill the same with drawings, models, &c., which shall illustrate consecutively the development and state of engineering improvement.

In various departments of engineering, extensive and interesting collections are promised. It seems most desirable that in metallurgical engineering, the importance and progress of which has been more conspicuous, perhaps, than that of any other branch, a creditable exhibit should be made.

In order, however, to secure any more space, it will be absolutely necessary to inform the officers of the exhibition within a very short time. There is time enough to collect the necessary drawings and models, all of which are in existence, and need only to be got together; but the collection will be of no avail, for want of room to exhibit it, unless the Commission can guarantee a specific amount of space.

* In reference thereto, members will please address the chairman of the particular sub-committee.

†Robert Briggs of Philadelphia, Pa., Chairman.

*Alexander L. Holley, of New York, Chairman.

Will you therefore please answer as soon as possible—within a few days—the following questions:

I.—Will you send to this Commission, by the middle of April, or before, any models or drawings referred to in the following list?* and if so—

II.—What important drawings of old or modern plant will be framed, and about what wall-space will they occupy in the aggregate?

III.—About what number of sheets of working drawings, old and modern, and on what general subjects, will you send for exhibition (in care of the Commission), in portfolios?

IV.—What models or machines will you exhibit, on what subjects, and what floor-space will they occupy?

Your prompt attention to these inquiries is earnestly solicited. The trouble and expense of selecting suitable drawings, models, &c., will in most cases be small, but the usefulness of such an exhibition, to the profession and to expert visitors, can hardly be overestimated.

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* *Drawings and Models*, illustrating the early stages, development and present state of American metallurgical engineering.

Historial drawings will be useful, even if they are soiled or damaged. Ordinary working drawings, or even sketches, if important, are solicited. All drawings should be dated in large figures, and if practicable, general explanations and historical facts should be written upon or attached to them.

I.—Iron and Steel.——Blast furnaces; stacks, stoves, blowing apparatus and arrangement; direct processes; sponge and blooming plant and apparatus; puddling furnaces and mechanical appliances; rolling mills and forges; roll-trains, hammers, squeezers, engines, boilers and other driving power, heating-furnaces (coal and gas), special machines for shaping metals, such as spike, nail and horse-shoe machines, tyre-mills, &c.; Bessemer machinery; details and general arrangement; open hearth steel plant and apparatus; crucible steel plant and apparatus.

II.—Metallurgy, other than Iron and Steel.—Gold, silver and copper mining plant and machinery: gold and silver, machinery for amalgamation and humid process; gold, silver and lead, smelting plant and machinery; zinc, nickel and quicksilver mining and metallurgical machinery; roasting and calcination, plant and machinery.

III.—Mining.—Quarries, open-work and hydraulic mining, works and machinery; tunnels and shafts, works and machinery; general underground work in coal mines; general underground work in metal mines; pumping and ventilation, works and machinery; mechanical preparation of ores, plant and machinery; labor-saving machinery, coal-cutters, rock-drills, &c.

IV.—Fuel.—Mechanical preparation of fuel, plant and machinery; cooking ovens and apparatus; hygro-carbon fuels, burning apparatus.

Space can probably be found for historical machines, or characteristic parts of machines. Some of great interest will be exhibited in other engineering departments.

On Metallurgical Engineering, No. 2.—In order to co-operate with exhibitors at the Centennial Exposition, in the various departments of engineering, this Committee will be glad to have you avail yourself of its office in the Main Exhibition Building, and of the services of its Secretary, on the following plan:

The committee proposes, not to alter the existing arrangements of exhibitors, but to promote the usefulness of exhibits already provided for. Inquirers for further information about such exhibits, or about engineering works and manufactories, or for letters or introduction to persons, may be directed by conspicuous cards attached to such individual exhibits, to the office of the Commission. Here they may examine such records, engravings, albums, &c., as exhibitors may wish to have shown or explained, receive directions about visiting works, procure introductions and make appointments. The committee does not constitute itself an advertising agency, however valuable such might be to exhibitors; it proposes chiefly to provide means of intercommunication between persons interested in metallurgical engineering.

The main object of the Society in taking part in the exhibition is to present a consecutive record and illustration of the progress of American engineering, for the information of all who are interested professionally or commercially. The foregoing scheme of co-operation with exhibitors is one feature of the plan. Another feature is to make a separate exhibit of those contributions only, which contributors shall wish the committee to take in charge and to put in consecutive order, such as drawings, models, historical machines or their characteristic parts, specifications, estimates, &c., referring to both old and recent works and practice.

A final feature is to make and prepare for publication, a series of memoirs, which shall preserve in convenient and permanent form, the record of engineering progress in America during the century, and of both American and foreign engineering, as shown in the exhibition.

In order to carry on this work, the committee makes the following requests:—

1st. That you will, should you wish to avail yourself of the facilities offered, inform the committee as to the general character of your proposed exhibits.

2d. That you will select and prepare for exhibition by the committee, such drawings, models, machines, statistics, &c., to illustrate progress, as are specified in circular No. 1.

3d. That in order to provide data for a permanent record, you will now, and during the

exhibition, furnish the committee with an account of the cost, amount of production and economical results of the metallurgical plant and machinery under your charge or ownership, at its various stages of development.

On Mechanical Engineering.* — This committee is instructed to aid and direct, to such an extent as may be found practicable, in the presentation at the Centennial International Exhibition of all illustrations of that progress in mechanical engineering which has taken place in this country during this first century of the existence of the United States as a nation.

A room has been assigned to this Society by the Centennial Commission in which to place a collection of carefully chosen exhibits, and it is desired to make the limited space accorded, as rich in illustration of modern progress in the branch assigned to this committee as time will permit. It will be necessary to use great care in selecting such illustrative exhibits from among the vast number which exist, in order to secure full illustration without important omissions, and avoiding the overcrowding of the space assigned.

It is desired to obtain—

I. Published works, monographs and manuscripts relating to subjects included in this branch. II. Drawings and photographs with descriptions of engineering construction. III. Models of all typical machinery. IV. Actual constructions, where interesting and of moderate size. V. Valuable and interesting relics. VI. Biographical sketches, portraits and busts of great American engineers, mechanics and inventors.

Classes I and II can be made to occupy but little space, and the collection can hardly be made too extensive. Books should, where in sufficient number, be forwarded in cases if possible ; monographs should, like the books, be carefully and substantially bound, and especial care should be taken to provide against injury of manuscripts by accident or by careless handling. Drawings and photographs should be arranged in drawers, portfolios or albums, according to the extent of the collection and the size of the sheet. Only exceptionally important and interesting drawings or photographs should be framed, as the wall space will be very limited and will be largely monopolized by models and portraits. Descriptions of drawings and models should be concise, accurate and amply provided with literal references—on models as well as drawings.

Relics exhibiting early engineering practice are especially desired, and exceptional efforts will be made to secure their accommodation. Only magnitude can prevent acceptance of this supremely interesting class.

Portraits and busts of American mechanics and inventors who have become famous in consequence of their success in the earlier days of American mechanical engineering, will be exceedingly interesting to the public at large, as well as to the profession, and well prepared biographical sketches will render them doubly valuable.

The growth of the steam engine and of the other motors, in their several typical forms should be shown with great fullness of detail ; our peculiar practice in machinery for transmission of power will be well illustrated in Machinery Hall, and this committee desires to exhibit fully the gradual change of method which has led to it ; mining machinery and mill work, textile machinery, metal and woodworking and agricultural machinery, all have a history which is capable of very full and accurate delineation on the plan proposed ; every manufacturer of experience and every establishment of long standing and reputation, will be able to make important contributions to one or another, if not to all, of the above named classes.

The committee desires, at the earliest possible moment, to learn the following :

(*a.*) What you can contribute or secure for this exhibit. (*b.*) The size, condition and exact character of each contribution. (*c.*) Whether the contribution will be placed in good order for exhibition, in the hands of the representative of the Committee, at a fixed date, at the rooms of the Society in the Exhibition Building. (*d.*) What incidental assistance you can give to this enterprise.

As the expenses of this work are borne wholly by voluntary contributions, it is desired that such expense shall be spared whenever possible, and any assistance in the collection and installation of exhibits will entitle the giver to the thanks of this committee and of the profession.

On Foundations and Masonry.* — In furtherance of the object set forth, the Sub-Committee on Foundations and Masonry earnestly requests you to contribute for exhibition at the Centennial Exposition, such models, plans, photographs, reports and descriptions of works belonging to this class, actually constructed in this country, as you may now have, or be willing to prepare. Models, plans and reports of the earlier works

* Robert H. Thurston, of Hoboken, N. J., Chairman.

* William Sooy Smith of Maywood, Ill., Chairman.

done by American engineers, or illustrative of the methods employed in their construction, will, it is believed, prove specially interesting, while it seems the plainest duty of American engineers to exhibit proofs of the skill they have acquired in the new processes they have so successfully employed in laying foundations and building masonry under extremely difficult circumstances.

It is proposed to devote the space allotted to the Society in the Exposition buildings, to the exhibition of—first: albums of plans photographs and descriptions of works; and —second: drawings and models of works and of machinery used in their construction, made generally upon a scale of one-eighth or one-fourth inch to the foot. Models or drawings of small machines, or of details of larger ones, may be made upon a larger scale.

Printed copies of reports and descriptions, which it is hoped will be largely supplied, will be judiciously distributed or sold at cost, as exhibitors may be pleased to direct.

As the total space to be allotted to our Society must be determined upon immediately, the Sub-Committee on Foundations and Masonry asks that you will, at the earliest possible moment, inform the Chairman at the Society's rooms, by letter, what you will contribute for exhibition and the space it will require.

On Railroads and Rolling Stock.*—This sub-committee is charged with the presentation of the progress and present condition of American engineering as exemplified in our railroads, locomotives and rolling stock, excluding, however, bridges and foundations and masonry, which are committed to other sub-committees.

In furtherance of this object, the aid and co-operation of the managers, superintendents, engineers, master-mechanics and car-builders of the various lines of railway in this country, and of the manufacturers and dealers in locomotives, sleeping and parlor cars, coaches, freight cars and railway supplies and materials generally, are respectfully and earnestly solicited, with the following suggestions as to the means of making such effective:

I. Manufacturers of locomotives, cars, etc., and dealers in railway supplies, who may become exhibitors at the Exposition, are requested to append to their exhibit, cards indicating that desired information about the articles exhibited or the place of manufacture, can be obtained from the Secretary of this Commission. Printed descriptions of articles exhibited, explaining their distinctive features, should be furnished to the Secretary for distribution.

II. Manufacturers, &c., whether exhibitors or not, are invited to furnish the committee with models, photographs and drawings of locomotives, cars, &c., made by them. Photographs should be arranged in albums for convenience of reference, with copies for distribution—to be given away or sold at cost, as contributors may require.

III. Superintendents and engineers of railways are invited to send to the committee, photographs of shops and stations, models of points, and other objects of interest presenting descriptive features; the photographs in albums preferred.

IV. Master-mechanics and car-builders are requested to contribute photographs or models of locomotives, cars, machinery, &c., constructed or designed by them, having peculiar advantages, with printed descriptions thereof.

V. Parties having information not generally known, relating to the early history of railways in this country, are requested to communicate the same to the Chairman, and the committee urgently requests that drawings, models, &c., of machinery in early use on railways of this country, be sent to the committee for exhibition at the headquarters of the Society on the Centennial grounds.

VI. Parties receiving this circular are earnestly requested to advise the undersigned of their intentions in regard to the subjects herein presented.

Suggestions are invited from parties interested, as to the best methods of realizing the object sought.

On Gas Engineering.*—It is of much importance to the gas interests of this country, that a representation of the progress of gas-lighting in America during the past century, should be made at the Centennial.

American engineers, superintendents and contractors of gas works, desiring to contribute plans, models of drawings of gas-works or gas machinery, are respectfully notified that their contributions will be received and taken charge of by a committee of the Society, and placed in the portion of the Centennial buildings set apart for this purpose.

If you have any plans, drawings or models you wish to contribute, please notify the Chairman at the earliest moment.

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* William P. Shinn of Pittsburgh, Pa., Chairman.

* James H. Armington of Brooklyn, N. Y., Chairman.

ON CANALS AND INLAND NAVIGATION.*—The Centennial Commission of the Society has had several meetings which have resulted in defining the duties and extent of the operations which it is expected to perform at the Centennial Exposition at Philadelphia. The previous somewhat diffusive views of some of the members have been concentrated, and it seems to be conceded that the Society and its Commission must not step between any of the exhibitors and the arrangements already perfected by duly authorized departments of the Exposition, but must present itself as an adjunct to aid in promoting the present plans.

Incidental to the main object of the Exposition, this Commission deems it proper to exhibit the outlines of all of the typical features of American engineering during the last century, and the various steps by which it has been brought to its present condition. This duty is not embraced in the programme of the managers of the Exposition.

For the purpose of carrying out this object, it has been decided by the Commission that it was advisable to collect all of the models, plans, descriptions, etc., bearing upon the commencement and the different stages of progress of engineering in America, and each of the sub-committees was requested to ask for the loan of all models, plans, etc., which bear upon the subject.

The Chairman of the Sub-Committee on Canals and Inland Navigation offers the following circular letter, not alone to the members of the Society or exclusively to engineers, but all persons who are interested in the subject, or who have any information in regard thereto.

It is expected that the reports of the sub-committees will be printed, that all communications will be duly credited by name to the contributor, and inserted in the report, in the language stated as nearly as possible, and that a copy of the whole report will be furnished to each contributor.

The tendency of the age is to greatly undervalue the importance of the interior lines of water transport, and in this country, as in Europe, the pioneers of the profession, the canal and river engineers, have lost their previous prominent position, and their most useful labors with all of their accumulated stores of professional treasures, are rapidly passing into oblivion.

The Society, by means of its Centennial Commission and the occasion which produced it, desires to collect and preserve the vast and important stores of information in regard to the early and successively improved plans and schemes of water transport in this country.

The wealth of information on this subject in the possession of living American engineers, is incalculable. Every year tends to its dispersion or useless application to unavailable sources of general information. If it is now collected, it will form a treasure store-house from which our successors may, at pleasure, recover many of the "lost arts."

The public works of the Dominion of Canada are of such importance and so immediately corresponding with those of the United States, that it is considered eminently proper that they should be fraternally embraced in a representation of the mother country's progress on this continent at the coming International Exhibition, and contributions from that country, of the character already indicated, are cordially solicited and will be most gratefully received and honored.

When specific information on other matters is desired, a printed form for a report can be prepared, but in regard to the subject referred to this committee it is difficult to define what should be asked for, from individuals. It is earnestly requested that printed reports and descriptions of the works of canal and inland navigation, and particularly serial reports, be sent to this sub-committee, either as a loan or for the library of the Society.

As a mere indication of what is particularly desired, the following questions, arranged under the heads of *canals*, *rivers* and *lakes*, are presented. It should be understood that information even upon apparently trivial and unimportant parts of the subject, will be gladly received.

I.—*Canals.*—1. What canals in North America have been constructed, of which you have any personal, published or other knowledge? Give the title, location, object, size, method of construction, date of commencement and completion, cost, the names of the prominent projectors, promoters and engineers, and also the results of its construction, its annual tonnage, revenue and expenses, now and at previous dates.

2. What is the width of the artificial channel way at the level of top water and at the bottom; its depth of water, width of top bank, side slopes, etc.?

3. What is the length of the locks between the gate-quoins, width of chamber, average and range of lifts and the total lockage?

4. A description of the aqueducts, waste-weirs, culverts, etc., and of the lock gates and water passages.

* William J. McAlpine of Albany, N. Y., Chairman.

5. The reservoirs for feeding water, the dimensions of the pool banks, water shed, etc., and the water shed and mean and ranges of water fall, and any experiments giving the proportions of the flow off.

6. Any information regarding the consumption of water by the infiltration and leakage of the banks and bottom, at the locks and at the other structures.

7. The kind of motive power which has been used, and the estimated cost of movement therefrom, per ton per mile.

II.—*Rivers.*—It is desirable to have embraced in the report, the methods and cost of cheap temporary works, as well as those of greater importance.

1. Describe any method by which logs or lumber are or have been transported through small water channels.

2. How was navigation conducted in the early history of the country upon the rivers (partially navigable) between the rapids and portages; in what sized vessels, how manned, and moved at what rate of progress and cost?

3. Also, accounts of removal of obstructions, such as logs, stones and sand-bars.

4. Referring to a class of more important river improvements, what works have been undertaken for lessening the velocity of the flow by extending the slope and reducing the rate of declivity; by jetties built to increase the depth of water in the channel, or to scour out bars; by dredging, and by dykes for contracting the stream?

5. What effects have been produced by any of the above mentioned operations, and under what circumstances have the plans undertaken resulted in failure.—The failure of engineering plans under well known circumstances, become as instructive as successes.

III.—*Lake and Large River Navigation.*—1. What are the general characteristics of vessels best suited to the navigation of our large lakes, and particularly of the chain from Superior and Michigan extending through the Ontario (Welland) canal and the St. Lawrence?

2. What is the carrying capacity and cost, and the daily cost of running such vessels by sail and by steam, and how far is the form regulated by the ports of shipment, harbors of refuge and the intermediate artificial canals?

3. How far can such vessels be moved through the above route before it becomes advisable to tranship the cargo, and is there a ratio between the proper size of the vessel and the length of the voyage?

It is suggested that whenever the trade of any port of shipment offers full cargoes for vessels, that the most economical size is determined by the cost of the vessel, and the cost of its movement, compared with the cost of loading and unloading, and the current expenses while the vessel is detained in port.

4. What is the cost of transport of full cargoes under the average circumstances of the case, by sail and by steam, on the lakes; and by the latter on specified rivers like the St. Lawrence, Ohio, Mississippi and Hudson, and by horse or steam power on the canals?

5. How much is the cost of transport affected by the comparative size of the vessel, and of the artificial water channel through which it is moved?

6. The steam engine applied to pumping water gives an average duty of forty to sixty millions of pounds of water lifted one foot high with each one hundred pounds of coal consumed. What is the duty, expressed in any similar manner, of steam engines applied to the propulsion of vessels of given dimensions and rates of speed, on long and short voyages on the ocean, lakes, rivers or canals.

A consideration of the subject will suggest a great many similar questions useful to bring out all of the information in the possession of engineers and others, relating to the matters referred to this committee.

Packages may be sent to the Chairman at the rooms of the Society, by express or mail. Whether such are intended as a gift to the library of the Society, or if they are for sale, at what price, and the address to which copies of reports are to be sent, should be stated.

On Hydraulic Motors and Machines.*—This sub-committee desires to ascertain what action will be taken to aid in carrying out, in this particular branch of engineering, the purposes of the Commission of the Society.

This portion of the Exposition will comprise:—Turbines and other water wheels; Hydraulic Engines; Hydrostatic presses and adaptations of same for various purposes; Hydraulic testing and weighing machines; Hydraulic jacks, cranes and elevators; Hydraulic valves; Pumping engines; Pumps; centrifugal, rotative and reciprocating, operated directly by steam, or indirectly from any prime mover, and used for drainage, for high lifts, or great pressures for water holding in suspension or transporting gritty and other materials; for oils, pulp and semi-fluids, and those adapted for particular locations or uses; Fire Engines; Water Meters, and in general any apparatus which may properly be classed as hydraulic machinery.

It should be understood that the Exposition does not relate to simple inventions, but to

* Charles E. Emery, of New York, Chairman.

apparatus which have been constructed and put in public and useful operation.

It is desired to obtain :—

1. Information as to decided advances which have been made in relation to any branch of the general subject, with accurate details of the nature of the developments or improvements and models, drawings, photographs or prints illustrating so far as possible the successive stages of development.

2. Models, drawings, photographs, cuts and written or printed descriptions of interesting hydraulic apparatus now in use in this country.

3. Authentic records of the performance of hydraulic apparatus, and particularly of careful tests of pumping engines, turbines and the like ; the records to completely illustrate the construction of the apparatus and give the full details of the trials.

Persons who have made collection of data of this character are requested to loan the same, or furnish copies thereof, for the general information of the profession, through the Commission.

4. Models of machines and apparatus illustrating special manufactures of interest to the profession, which will be received, if constructed with neatness and taste, with addresses marked in a plain and simple manner.

Information is requested as to any historic machines which can be procured, for exhibition in some part of the grounds under the direction of the Commission.

As the Exposition will be entirely voluntary, and funds for establishing the same derived from contributions, it is desirable that all exhibits should be submitted in proper shape for immediate erection and examination, without liability to injury.

The size of models or other proposed exhibits should be given.

On Park and Landscape Work, Surveying and Geodesy.*—This committee asks you to prepare and send for exhibition any contributions which will further these objects. Will you also communicate this request to persons whom you think may be able to assist?

Any matter which may be of use in preparing memoirs on the state and progress of engineering in America, in this branch, will be valuable and will be properly credited. Dates should be written upon all drawings or models, and a brief explanation and historical record be attached.

The Commission invites you to avail yourself of its office and the services of its Secretary. Please inform the Chairman of this Sub-Committee, what you may be able to contribute or obtain, and also make any suggestions which occur to you in connection with the subject.

* John Bogart, of New York, Chairman.

TESTS OF AMERICAN IRON AND STEEL.*

During the past year, the United States Board appointed to test Iron, Steel and other Metals, under authority of an Act of Congress procured by a committee of the Society, has been organized, has prepared the plans of investigations to be adopted, and has appointed its committees on the several subjects to be studied.

The general plan is announced, and is to be a thoroughly scientific and systematic exploration of the field assigned to the Board. Materials are not only to be tested and the results stated as those derived from the examination of a metal of a conventional denomination, but the test-piece, in each case, will usually be examined to determine how far peculiar qualities are attributable to peculiarities of chemical composition and of physical structure.

Circulars have been issued† by the committees of the Board requesting men of science, engineers and manufacturers of metals to communicate to the Board all information which they may be able to submit relative to the subjects under investigation. A considerable amount of valuable material has thus been obtained. Even foreign correspondents of the Board exhibit great interest in the matter, and some of the most useful papers received by the Secretary were sent in by Mr. Forrest, the Secretary of the British Institution of Civil Engineers, Mon. Tresca, of the French Conservatoire des Arts et Metiers and other well known European authorities.

A chemical laboratory has been established at Watertown Arsenal and the chemist to the Board, Mr. Andrew A. Blair, formerly of St. Louis, has already done a large amount of work upon irons, steels and other metals and alloys, and the specimens thus examined as to composition are subjected to the several kinds of mechanical stress to discover the effect of composition in determining resistances for distortion and rupture.

* Continued from Vol. 1, page 314.
† Do., pages 270, 284, 295.

A series of steels is in preparation under the direction of the Committee on Chemical Research, in which other elements being retained constant in amount, the carbon varies regularly from 0 to 2 per cent.; another series, with carbon uniform, has silicon in varying proportions; another set varies in phosphorus, still another in sulphur, and another series is variable in manganese. In each series, one element varies between wide limits, while the other elements are all retained as uniform as possible. The work of the melter is checked by analysis, and the specimens are then tested mechanically. This investigation, greatly as it has been needed, has never before been even attempted. It is considered by the members of the Board as likely to prove the most valuable research ever made in this direction, and the only one in which the chemist and the engineer have ever systematically joined forces in making such an exhaustive and scientific investigation.

The Committee on Abrasion and Wear is engaged in collating information relating to this subject, and is making experiments at the Stevens Institute of Technology on the abrasion and wear of the metals, and on the effect of lubrication in reducing it. The Chairman is fitting up machinery and apparatus for use in further investigation. A considerable amount of work has been done.

The Committee on Armor Plate is engaged in collating information from domestic and foreign sources that may be valuable in determining the qualities requisite in armor plate, and how those qualities are to be secured. The records of the Army and Navy Departments and of the British Admiralty are considered to be the most promising mines of information to be worked by this committee.

The Committee on Chemical Research has charge of the chemical work referred to.

The Committee on Chains and Wire Rope is endeavoring to determine the character of metal best adapted to making chain and rope, and the proper form and proportions of link, and is working up the data which have long been collecting at the Navy Department. The later experiments of Com. Beardslee are extensive in range, and that officer is collating and arranging the records for the use of the Board. Further experiment will fill up any hiatus that may be detected. The Navy Yard at Washington, where this work is going on, affords peculiar facilities not only for testing, but for making chain cable of any desired size, form of link or quality of metal.

Work already done there by the Chairman of this committee has revealed serious defects in accepted tables of sizes and strength, and has indicated the rate of variation of strength with variation of size of bar, and permitted the formation of a new and trustworthy table.

The Committee on the Corrosion of Metals is investigating the conditions affecting the corrosion of metals in use. Some information has been collected, some chemical work has been done, and much more work is projected for the ensuing year.

The Committee on the Effects of Temperature has planned an extended investigation of this subject and is gathering information from various sources. The research will be commenced by the Chairman during the coming year, if the Board is sustained in its work. The Chairman has already collated all published information accessible in periodical literature, has made some preliminary experiments, and is receiving some information from various directions.

The Committee on Girders and Columns has a plan of operations which includes elaborate investigations of the strength of materials in columns and girders of various forms and proportions. This is the most formidable and expensive of the researches to be undertaken by the Board, and the power and accuracy of the 400 tons testing machine will be fully taxed in this work. The committee is receiving the co-operation and active aid of some of the largest manufacturers of beams and girders in the country. The results of experiments already made have been communicated to the committee by the engineers of railroads and of mills, and in other cases important and costly experiments have been undertaken by private incorporated companies (the Board has been invited to be present and to assist in the work if it should seem desirable); these results are to be given the Board, such sizes and proportions as the Board may desire to test are to be made and all necessary labor furnished without any expense to the government. Bridge builders, civil and mechanical engineers and architects are corresponding with the Board on this subject, and the greatest interest and a most gratifying public spirit are said by the members to be exhibited on all sides.

The Committee on Malleable Iron has collated a large mass of valuable information, and the records of a great number of experiments, and, among other important matter, has obtained an extensive collection of experimental determinations of the effect of time upon the elevation of the elastic limit by strain, during periods varying from a few seconds up to a year. The variation of quality due to differences of size and form of section of the bar and the modification of

strength, ductility and resilience are under investigation. The Chairman of this committee is also determining the influence of proportions of test-pieces upon their ultimate resistances.

The Committee on Cast Iron is pursuing a course similar to that of the Committee on Malleable Iron with similarly promising results.

The Committee on Metallic Alloys has made an investigation of the strength and other properties of bronzes, which may be taken as typical of the kind of work to be done by the Board.

Several series of copper-tin alloys were prepared, varying in some cases by regular percentages, and in others by chemical equivalents, and were cast in bars of 1 inch square section and about 20 inches long. Their temperatures of fusion were taken at casting, and some were cast in sand, and others in an iron ingot mould. The weighing was carefully done in a Coast Survey balance, in the Physical Laboratory of the Stevens Institute of Technology. A set were reserved for the determination of the coefficient of expansion, by Dr. Mayer. The others were broken by transverse stress, one set by dead loads, and others in the transverse testing machine of the Mechanical Laboratory, and deflections and tests were recorded to the fourth place of decimals, in inches, and also in meters with equal precision. The logs were made up, and the results were also laid off graphically. The curves revealed some peculiar and important facts. The fractures were photographed and, where peculiar, were reported upon by Prof. Leeds, the chemist and mineralogist of the Institute. From the data obtained, the coefficients of elasticity were calculated and recorded.

Complete sets were next broken by tension, and the results recorded and worked up as with the transverse tests, and the logs and curves compared, and a series of compression specimens were made up as companion test-pieces.

The full series was finally tested in the autographic recording machine and from the strain diagrams, their strength, elasticity, ductility, resilience and homogeneousness were deduced, and the law of variation worked up graphically. The effect of strain in elevating the elastic limit was observed.

All specimens were examined by the chemist, and a comparison made between the proportions by mixture and composition in the bar which exhibit the loss of metal, and to some extent, change of physical character, produced by melting and casting. Some curious and interesting scientific facts are revealed by the research, and a new mineral consisting of stannic acid, with a trace of copper in magnificent needle-shaped crystals was produced in some cases, which has been subjected to examination and analysis by Prof. Leeds.

A determination of specific gravities of the metals as purchased, as cast and as compressed mechanically and in mass and in a state of fine division, concludes this research.

A similar research is in progress, under the direction of this committee, by Prof. Thurston, its Chairman, which is intended, also, to be as complete and accurate as the resources at command will permit.

Before entering upon this work, the Chairman collated all published material bearing on the subject, and a preliminary report of about one hundred pages embodies the most important facts previously determined, and contains the bibliography of this subject of copper-tin alloys. This work was supplemented by making graphical records of the experimental work of Mallet, Mathiessen, Calvert, Johnson and others on the conductivity for heat and electricity, the specific gravity and other properties of copper-tin alloys, as had been examined by them. It was the intention to profit by facts already acquired by acknowledged authorities, to complement them by the new investigations, and to avoid useless repetition of work involving serious expenditure of time.

This paper is itself regarded as exceedingly valuable, and particularly to the mechanical engineer, as it is the first time that these earlier researches have ever been collected and put in an accessible and compact form.

A similar preliminary research is made to preface the examination of the copper-zinc alloys, and the same plan will be pursued throughout.

The Committee on Orthogonal Strains is planning a series of experiments to determine the laws of the resistance of materials under simultaneous stresses acting in rectangular directions, as in the case of a rod subjected to torsional or shearing simultaneously with tensile or compressive stress. The subject has been entirely unstudied up to the present time.

The Committee on Physical Phenomena is preparing to seek for the phenomena induced by stress in the various physical modes of energy, as the development of magnetic, electric and thermal actions. The fact of the development of heat and electricity has long been known, but no systematic or scientific

investigation has ever been made in this direction.

The Committee on Steel produced by Modern Processes is working with the Committee on Chemical Research. It is collecting also the vast mass of material available and will endeavor to make a report which shall be of great and permanent value.

The Committee on Re-heating and Re-rolling is to test iron, &c., in the several stages of manufacture, refined and unrefined, and to observe the effects of successive re-heats, of reworking and rolling, to determine, if possible, what amount of working is demanded by different irons, and what are the temperatures which will practically give the best results.

The Committee on Steel for Tools is making an extended series of experiments at the Washington Navy Yard to determine the value of various steels for tools. A large collection of steels is made ; their composition is determined, and they are there carefully tested by setting them at work—turning, planing, boring and chiseling—and their behavior and their composition being thus ascertained it will probably be easy to learn the chemical and physical characteristics of the best tools. The names of makers are of no importance in this investigation, and are not to be reported. The Board, in all its work, will avoid reference to makers of material in any way that may injure any manufacturer directly or indirectly. Scientific knowledge of directly practical value and engineering facts and figures, sole y are sought.

The testing machine ordered by the Board is well under way, and it is expected will be soon completed, when the Board will be prepared to undertake the heavier and more accurate work laid out by its committees. The machine was designed by Albert H. Emery, and has an attachment designed by Charles E. Emery, for obtaining an autographic strain diagram. Its capacity is 800 000 pounds, in both tension and compression, The committee of the Board appointed to examine and report upon it, considered it an extremely accurate and effective form of machine, and far superior to any other then known to its members.

The building, the foundation, and the accessory machinery are all in hands, under the charge of the several committees of the Board entrusted with these matters, and will be ready for the machine before its completion.

The Board is not prepared to make a report, as all the work is in progress and none yet completed. If desired, the members state their willingness to present to the appointing power, and to Congress, a statement of their status. They expect to be able economically, to use $50,000 during the year 1876-7.

At a meeting of the Board of Direction of this Society, held February 9th, 1876, the plans and work of the Board were considered and the following adopted :

Whereas ; the Board of Direction of the American Society of Civil Engineers has informed itself as to the work performed, in hand, and proposed by the United States Board appointed to test Iron, Steel and other Metals, and has been led by such information to the following conclusions :

1st. That the 400-tons testing machine ordered by the Board and now nearly three-fourths completed, has been built under extraordinarily close inspection, and is remarkably well built, both as to material and workmanship.

2d. That even without the use of this testing machine, the Board has accomplished a large amount of useful work, viz. :—The establishment of a chemical laboratory and the engagement of an experienced chemist ; the arrangement of a comprehensive series of comparative chemical and physical tests and the already completed analyses and preparation of specimens for test from a large number of irons and steels containing different hardening and toughening ingredients ; also the preparation of a complete series of specimens of the various bronzes, a number of which has been submitted to analysis and to a part of the necessary mechanical tests—the results of which must be that all these materials can be more closely adapted to the large variety of stresses they will have to bear in use, thus avoiding the present excess of material and cheapening structures and machinery as well as increasing their safety, and also making the production of materials a matter of scientific synthesis rather than a trade secret ; that the Board has collected and classified a mass of information about the useful work done elsewhere in testing metals ; that it has commenced a comprehensive series of experiments on tool-steels and arranged for the construction of some large iron and steel columns and girders for tests ; that it has availed itself of the results of a series of tests of wrought iron, especially in the form of chain-cables, previously undertaken by one of its members for the Navy Department, and has commenced more comprehensively carrying out these experiments and completing their usefulness by means of chemical

analysis; and that it has prepared as far as its means will allow, to undertake tests in other departments.

3d. That the character of the experiments undertaken and proposed by the Board is judicious and comprehensive, and if carried out on these plans, will be of great value to engineers, constructors. producers of constructive materials and the public at large.

4th. That the information derived from these experiments should be of the first and greatest value to the Government directly, in its own constructions of vessels, engines, boilers, cannon, armor-plates, light-houses, etc.

5th. That in order to carry out to comprehensively useful results, the series of tests already undertaken, the Board will require a considerable sum of money, chiefly to increase its chemical department and to pay for material to be tested, and for the manufacture of such new shapes and compounds as current tests may prove it desirable to experiment upon.

Therefore it is Resolved;—That the Board of Direction of the American Society of Civil Engineers respectfully petitions the honorable Senate and House of Representatives in Congress assembled, to grant to the United States Board appointed to test iron, steel and other metals, the sum of fifty thousand dollars, to be expended in carrying out the investigations of the Board, as explained in its various printed circulars.

SELECTIONS FROM CORRESPONDENCE.

Laying Masonry in Cold Weather.—Information is desired on the following, concerning which nothing is found in any of the hand-books to which the writer has access.

1st. What deleterious effect (if any) is caused by laying cement masonry at low temperature, and what is the approximate limit of temperature, below which, cement that is mixed with a saturated solution of salt should *not be* laid?

2d. Where piers are built in such cold weather that a slow-setting cement probably freezes before setting, does any settlement take place on the advent of warm weather?

The following is from a letter of William P. Shinn, January 31st, referring to the proposed amendment to the By-Laws.

Concerning Conventions.*—I am in favor of the Addition to Section 1 as amended, with the exception of the amendment substituting "may" for "shall" in the second paragraph referring to the holding of a regular meeting of the Society.

In regard to the propriety of this amendment, I would suggest:—

That if the substitution of "may" is adopted, some authority has to decide in advance of the Convention whether or not a regular meeting shall be held during the Convention. By what authority shall that question be determined? It must be either by the Board of Direction, or by the Society at one of its previous regular meetings, or by submission to the Society by the letter ballot.

The whole object of the adoption of this amendment to the Constitution was to take away from the Board of Direction, and from the limited number of members who are usually able to attend the regular meetings. the power to decide upon the questions—*first*, as to the holding of a convention, and *second*, as to having a business meeting at such Convention.

* * * At all of the Conventions at which I have been present, viz.: Chicago, Louisville and Pittsburgh, the almost unanimous sentiment was in favor of such an amendment to the Constitution, as would make the body of the Society or its largest representation ever obtained—which, as you are aware, is only at the Annual Convention—competent to transact the most important business of the Society, and to designate and regulate the policy of the Society in a general way by discussing and acting upon subjects involving questions of policy.

It was made strongly apparent, both at the Louisville and the Pittsburgh meetings, that the non-resident members desired to have at least one meeting of the Society annually, at which their vote would have that preponderance of numbers to which the non-resident members are is really entitled, but which, except in matters decided by the letter ballot, they have no other opportunity for the expression of their views.

I therefore hope that in this amendment, it will not be left discretionary with the Board of Direction or the resident membership, to decide whether or not, the non-resident members shall have that one opportunity accorded them per annum to express their views by voice and vote upon all subjects of importance to the Society. * * *

This matter of justice to the non-resident members, is one deserving of the highest con-

* For a previous letter, see page 8.

sideration by the Board of Direction, and members resident in, and adjacent to New York. Many of the non-resident members have heretofore felt that there was a disposition on the part of some of the resident members to cut them off from all participation in the government of the Society; witness, for instance, the struggle over the adoption of the letter ballot, and the monthly publication of Transactions. While, at the Annual Meeting at which those questions were decided, the yeas and nays were not, I believe called or recorded, I think I risk nothing in saying, that the vote of the non-resident members was unanimous for both of those measures, and the only reason why they were not adopted by a vote of three or four to one was because it was not convenient for most of the non-resident members to attend. The sentiment of the Louisville Convention * * * was almost unanimous in favor of the adoption of those measures, and yet you will remember what a strenuous effort was made to ignore that sentiment, and defeat those measures which two years' experience have now satisfactorily shown, I think, to be of incalculable benefit to the Society.

The success of our Society depends upon our policy being broad and comprehensive, and its management being in accord with the majority of its membership; that majority is overwhelmingly non-resident, and I would urge upon the Board of Direction and the resident members to do nothing which might be interpreted by the majority or non-resident members to be an intentional disregard of their rights.

METRIC SYSTEM OF WEIGHTS AND MEASURES.—The following is from a letter of Frederick Brooks, Chairman of Committee of the Boston Society of Civil Engineers.

With this I send a circular which our committee has prepared, similar to the one addressed to the Society, one point of which I am afraid will provoke criticism. In the address "To the Members of the American Society of Civil Engineers," it was stated of the metric system that "its use has been made compulsory over the enormous territory of British India." To support that statement there is to be found in the memorial of the American Metrological Society a clause "that, in the legislation for the British Indian Empire, embracing a population of 150 000 000 souls, the metric system has been actually adopted in preference to the British"; and furthermore, in J. P. Putnam's "Metric System of Weights and Measures" (page 22), the following sentence: "The first great step of a practical nature was taken in 1870, when it was made obligatory in British India, with a population of over 150 000 000." An engraving of a bridge on the Holkar State Railway in India, that appeared in *Engineering* for October 16th, 1874, with the dimensions, great and small, peculiar to that bridge, given to meters and millimeters, appeared consistent enough.

From what I have recently learned, however, I think these statements convey a wrong impression. In the appendix to Dr. Barnard's "Metric System" (page 189), the facts are put as follows:—"An act was passed in 1870, to regulate the weights and measures in British India. The act constituted the primary standard of weight, the *Ser*, of the same weight as the kilogramme, and the primary standard of length, the metre; and it empowered the Governor-General in Council to cause such new weights and measures to be used by any government office or municipal body or railway company; and to require that, after a date to be fixed, all or any of the weights and measures of capacity aforesaid shall, in every district, be the basis of the dealings and contracts of all persons engaged in any specified business or trade. It also provided that after the date fixed in any such notification, all dealings or contracts made by the officers, bodies, companies or persons so mentioned, for any work done or goods sold by weight or measure, shall, in the absence of a special agreement to the contrary, be deemed to be had or made, according to weights and measures directed in notification to be used."

From this I infer that the metric system is in a fair way to be used in British India when the Governor-General in Council shall make up his mind to it. I am not aware that he has as yet introduced it to any great extent. In Ewing Matheson's Works in Iron, Bridge and Roof Structures (page 291) where he cites Blue Book, Standards' Commission. (Second and Fifth Reports of the Commissioners, London, 1868-71), it is said that "up to the present time (January, 1873), repeated applications to Parliament to legislate in favor of the decimal system have been unavailing, and the only steps that have been taken in that direction have been towards the permissive use of decimal measures and the construction of some of the Indian State railways with a gauge of one metre." Our circular of Jan. 10th, 1876, accordingly says, Great Britain "has adopted the meter gauge in the construction of some of the Indian State railways."

I very much regret that what appears to be an overstatement, should have been made in this matter.

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

Admiralty Lights of the World, corrected to December, 1875. (English Government Publication.) London. 8vo. British Islands; United States of America, each 1s. 6d.; British North America; France, Spain, &c.; Mediterranean, &c.; North Sea, &c.; South Africa, &c., each 1s.; South America; West Coast of Africa; South America, each 6d.

Alcohol, Cantor Lectures on —— by B. W. Richardson. London, with Introduction by Willard Parker. New York. 12mo. *National Temperance Co.* (Announcement.)

Algebraical Equations, Treaties on the Theory and Solution of —— John Macnie. New York. 8vo. *Barnes.*

Anatomy of the Invertebrates. C. Th. V. Siebold, trans. from the German, with Additions and Notes, by Waldo I. Burnett. Boston. 8vo. *Campbell.* (Announcement.) $5.00.

—— (Comparative) and Physiology of the invertebrate Animals. Richard Owen. Boston. 8vo, illus. *Campbell.* (Announcement.) $7.50.

—— of the vertebrate Animals. Richard Owen: Vol. I. Fishes and Reptiles; Vol. II. Warm-blooded Vertebrates; Vol. III. Mammalia, including Man. Boston. 8vo, illus. *Campbell.* (Announcement.) $20.00.

Army List, new Annual—for 1876. H. C. Hart. London. 8vo. *Murray.* 21s.

—— Register, U. S. official, for January, 1876. Washington. 12mo.

Architects and Engineers' Societies; Reports of Proceedings in 1st general Meeting of the German —— —— September 23d, 26th, 1874. Berlin. 8vo. (German.)

Architectural Iron-Worker's Manual. W. H. Freyer: a Series of practical Ideas and tabulated Results, regarding the best Arrangement and incidental Expenses of a Foundry, best Forms of Cupola Beams, etc. New York. *Wiley & Sons.* (Announcement.)

—— Annual Report of the Supervising —— to the Secretary of Treasury for 1875. Washington. 8vo, illus.

Architects and Builders' Pocket Book of useful Memoranda and Prices. W. Young. 3d ed. London. 16mo. *Spons.* 3s. 6d.

Architecture, a concise Glossary of Terms used in Grecian, Roman, Italian, and Gothic Architecture. John Henry Parker. 4th ed. rev. London. *Van Nostrand.* (*New York.*) $3.75.

—— Swiss gothic Model Frame Cottage; Drawings, comprising the working Plans, Elevations, principal exterior and interior Details; also complete Specifications and Bill of Materials. D. T. Atwood. New York, letter press and plates. *Bicknell.* $10.00.

Arts, the fine Arts and their Uses; Essays on the essential Principles and Limits of Expression of the various Arts, with especial Reference to their popular Influence. William Bellars. London. 8vo. *Smith & Elder.*

Astronomical and metrological Observations made in 1873, at U. S. Naval Observatory. 4to. Washington. 9s.

Canal, History of the Suez Canal; a personal Narrative. Ferdinand de Lesseps, trans. from the French by Henry Drummond Wolf. Glasgow. 12mo. *Blackwoods.* 2s. 6d.

Chemical Problems, a Key to the Series of —— —— T. E. Thorpe. London. 16mo. *Macmillan.* (*New York.*) $0.50.

Chemistry, theoretical, practical, and analytical: as applied to the Arts and Manufactures, by Writers of Eminence, in 40 Parts. Philadelphia. 8vo, illus. Parts 1-5. *Lippencott.* Per part, $0.50.

Drainage of Towns and Buildings. G. D. Dempsey. 6th ed. (Weale's Series.) London. 12mo. *Lockwood.* 2s. 6d.

Drawing Cards, Freehand.—Sets 1 to 4. London. 8vo. *Collins.* 1s.

Education Bureau of —— Circulars of Information; No. 8, 1875. Schedule for the Preparation of Students' Work for the Centennial Exhibition, as reported by the Committee of the Department of Superintendence of the National Educational Association, appointed at Minneapolis, in 1875. Washington. 8vo.

Electricity. W. S. Harris. 7th ed. (Weale's Series.) London. 12mo. *Lockwood.* 1s. 6d.

—— and the electric Telegraph. George B. Prescott. New York. *Appletons.* (Announcement.)

Engineers, annual Report of the Chief of —— U. S. A., to the Secretary of War, for 1875. 2 vols. Washington. 8vo, illus.

—— Architects and Contractors' Pocket-Book. London. 12mo. *Lockwood.* 6s.

—— Hand-Book to the Local Marine Board Examinations, W. H. Thorn, with a Supplement containing the Answers to the elementary Questions. 5th ed., rev. and enl. Sunderland. 8vo. *Reed.* 6s.

—— Pocket-Book for 1876. Adcock's. London. 12mo. *Simpkin.* 6s.

Farming, an Introduction to practical —— T. Baldwin. London. 16mo. *Macmillan.* (*New York.*) $0.75.

Filth-Diseases and their Prevention. John Simon. 1st American Ed., printed under the Direction of the State Board of Health of Massachusetts. Boston. 16mo. *Campbell.* (Announcement.) $0.75.

Food and its Adulterations, and the Methods for their Detection. Arthur H. Hassel. London. 8vo, illus. *Longmans.* 24s.

Gas, Metropolis Gas Bill. Index to the Report of the Committee. (Parliamentary Report.) London. 8vo. 11d.

Gazetteer, United States Centennial Gazetteer and Guide. Philadelphia. 8vo, illus. *Burley.* $2.50.

—— Report of the geological Survey of North Carolina. Vol. I.—Physical Geography Resume. Economical Geology. W. C. Kerr. Raleigh. 8vo, illus. (*Van Nostrand, New York.*) $5.00.

Geological and geographical Survey of the Territories, Bulletin of— Washington. 8vo.

Geology, Principles of —— Charles Lyell. 12th ed. 2 Vols. London. 8vo, illus. *Murray.* 32s.

Geometry, Descriptive —— J. F. Heather. (Weale's Series.) New ed. London. 12mo. *Lockwood.* 2s.

Harbors, the Cry for national —— and its Connection with our defective System of public Harbor Legislation. E. K. Calver. London. 8vo. *King.* 1s.

Harmony, Theory of —— with Questions and Exercises, for the Use of Students. John Stainer. 3d ed. London. 12mo. *Novello.* 7s. 6d.

Hydraulic Motors, including all Kinds of Water-Wheels, etc., trans. from the French of M. Bresse, by F. A. Mahan; new ed., with French Measures converted into English. New York. 8vo, illus. *Wiley.* (Announcement.) $2.50.

Insurance, Fire Insurance Cases, being a Collection of all the reported Cases on Fire Insurance in England, Ireland, Scotland, and America; from the earliest Period to the present Time, chronologically arranged. Vol. 4. Covering the Period 1853-64, with Notes and References. Edmund H. Bennett. New York. 8vo. *Hurd & Houghton.* $7.50.

Iron ores of Missouri and Michigan. R. Pumpelly, T. H. Brooks, and Adolph Schmidt. 2 vols. New York. 8vo, text, folio plates. *Putnam.* $10.00.

Labor and Capital. Conflict of —— —— ; Albert S. Bolles. Philadelphia. 12mo. *Lippencott.* (Amendment.)

Maps; Account of the Methods and Processes adopted for the Production of the Maps of the United Kingdom, drawn up by Officers of Royal Engineers employed under Lt. Gen. Sir Henry James, R. E. London. 4to, illus. (*Van Nostrand, New York.*) $7.00.

Mechanical Engineers, Institution of —— Proceedings, November, 1875, Birmingham. 8vo.

Meteorological Instruments. Instructions in the Use of ——; Robert H. Scott. London. 8vo, illus. (*Van Nostrand, New York.*) $0.75.

Microsopical Journal, Monthly. Vol. 14. London. 8vo. *Hardwicke.* 10s. 6d.

Mineral Statistics, 1874. (English Government Publication.) London. 8vo. 2s. 6d.

Mining, the Explorers', Miners', and Metallurgists' Companion. J. S. Phillips. 2d ed., illus. Boston. *Phillips.* $11.00.

Money, Currencies, and Banking. Charles Moran. New York. 8vo. *Brentano.* $0.40.

Music, general History of the Science and Practice of —— new ed., with the Author's Posthumous Notes. John Hawkins. 2 Vol. London. 8vo. *Novello.* 40s.

Musical Terms, a Dictionary of—John Stainer and W. A. Barrett. London. 8vo. *Novello.* 16s.

Natural Science, a short History of —— —— and of the Progress of Discovery, from the Time of the Greeks to the present Day. A. B. Buckley. London. 8vo, illus. *Murray.* 9s.

Nature, Lessons from ——, as manifested in Mind and Matter. St. George Mivart. (London reprint.) New York. *Appletons.* (Announcement.)

Nautical Magazine for 1875; new Series. London. 8vo. *Simpkin.* 15s.

Navy Register of the U. S. to January 1st, 1876. Washington. 8vo.

Ornaments, modern Gothic —— E. Plassman. New York. large folio, 32 photo-lithographic plates. *Lindeman.* $12.00.

Parasites, (Animal) and Messmates. P. J. Van Beneden. (International scientific Series.) New York. *Appletons.* (Announcement.)

Philosophy, a History of ancient and modern —— Joseph Haven, New York. 12mo. *Sheldon.* $2.00.

Physics, a new Law in ——; the Letters of Alpha, a new Theory of the Origin of Light, Heat, Color, and the molecular and atomic Aggregation of Matter in the Creation of the Universe. B. Action. Boston. 16mo, illus. *Campbell.* (Announcement.) $0.50.

Physiology, a new Manual of —— a Course of Lectures, as delivered by Prof. Kuss, at the Medical School of the University of Strasbourg, ed. by Mathias Duval; trans. from the 2d and rev. ed. by Robert Amory. Boston. 12mo, illus. *Campbell.* (Announcement.) $2.50.

Price Book, Atchley's Civil Engineers' and Contractors' Estimate and Price Book. W. David Haskoll. London. 8vo. *Lockwood.* 6s.

Prices—Spon's Engineers' and Contractors' illustrated Book of Prices of Machines, Tools, Ironwork, and Contractors' Material; for 1876. London. 4to, illus. *Spons.* $3.00.

Printer's new Hand-Book, a Treatise on the Imposition of Forms, with Tables of Signatures, etc. Geo. H. Bidwell. New York. 18mo. *Bidwell.* $1.00.

Printing, the Invention of —— a Collection of Facts and Opinions descriptive of early Prints and Playing-Cards, the Block-Books of the 15th Century, the Legend of the Sourens, Janszoon Coster, of Haarlem, and the Work of John Gutenberg and his Associates. Theo. L. De Vinne. 1st part. New York. 8vo, illus. *Hart & Co.* $1.00.

Prompt Computer, for the Use of Book, Newspaper, and Job Printers in computing Earning of Employes. George H. Bidwell. New York. 8vo. $2.00.

Punctuation, general Rules for —— and the use of capital Letters. A. S. Hill, new ed. rev. and enl. New York. 16mo. *Sever.* $0.25.

Quantities and Measurement. (Weale's Series.) A. C. Beaton. 4th ed. London. 12mo. *Lockwood.* 1s. 6d.

Railroad Commissioners; 7th Annual Report of the Board, for State of Massachusetts, January, 1876. Boston. 8vo.

Railway Map of metropolitan —— Tramways, and miscellaneous Improvements for Season 1876. Stanford. London. *Stanford.* 7s. 6d.

Rules of Order, Pocket Manual of —— —— or deliberative Assemblies. Part 1. Rules of Order; a Compendium of parliamentary Law, based upon the Rules and Practice of Congress. Part 2. Organization and Conduct of Business; a simple Explanation of the Methods of organizing and conducting the Business of Societies, Conventions, and other deliberative Assemblies. Henry M. Robert. Philadelphia. 8mo. *Griggs.* $0.75.

Sewage, a Guide to the sewage Question for 1876, treated from a sanitary, economical and agricultural Point of View; in 2 Parts. H. Hoffert. London. 8vo. (*Van Nostrand, New York.*) $0.40.

Science Gossip, 1875. London. 8vo. *Hardwicke.* 5s.

—— Progress of —— a short History of Natural Science, and the Progress of Discovery, from the Time of the Greeks to the present Day, for Scholars and young

Persons. A.B. Buckley. NewYork. *Appletons.* (Announcement.)

—— Working, Wages and Wants of —— R. A. Proctor. London. 12mo. (*Van Nostrand, New York.*) $0.75.

Screws, Theory of ——: a Study in the Dynamics of a rigid Body. Robert Stowell Ball. Dublin. 8vo. *Hodges.* 10s. 6d.

Slide Rule, C: Hoare. 12mo. (Weale's Series.) London. 12mo. *Lockwood.* 3s.

Steam Machinery, Report of the Trial of —— —— U. S. Revenue Steamer "Gallatin." Dec. and Jan., 1875. Washington. 4to.

Storms, Remarks on revolving —— (Government publication.) London. 8vo. 3d.

Telegraph Code, International—London. 8vo. *Hamilton.* 25s.

Telegraphy. W. H. Preece, and J. Sirewright, (London reprint.) New York. 12mo, illus. *Appletons.* (Announcement.) Do. London. 12mo. *Longmans.* 3s. 6d.

Tide Tables for 1876. (English Government Publication.) London. 8vo. 3s. 6d.

Timber Importer's, Timber Merchant's, and Builder's Standard Guide. Richard E. Grandy. 2d ed., rev. London. 12mo. *Lockwood.* 3s. 6d.

Trigonometry, Walmsley (John), an introductory Course of Plane —— and Logarithms. John Walmsley. 3d ed., rev., cor., and imp. London. 12mo. *Hodgson & Son.* 2s. 6d.

Tunnel, Channel Tunnel Reports, Correspondence, &c., Maps. (Parliamentary Report.) London. 8vo. 3s. 10d.

—— St. Gothard Tunnel. Daniel K. Cluck. Minutes of Proceedings, Institution of Civil Engineers. London. 8vo.

War, the Franco-German —— 1st Part: History of the War to the Downfall of the Empire. 7th Section: Advance of the 3d Army, and of the Army of the Meuse against the Army of Chalons; Battle of Beaumont, with Plans, a general Map, and numerous Sketches; trans. from the German official Account at the Intelligence Branch, by F. C. H. Clarke. (English Government Publication.) London. 8vo. 6s.

Water, a Guide to the microscopical Examination of drinking Water. J. D. MacDonald. London. 8vo, illus. (*Van Nostrand, New York.*) $3.75.

—— Metropolis Water Companies. Accounts for 1874. (Parliamentary Reports.) London. 8vo. 5d.

Weaving, a practical Treatise on the Construction of the Power Loom and the Art of Weaving all Descriptions of Texture produced by Leaves of Heddles. Alexander Brown. New ed. London. 12mo. *Simpkin.* 3s. 6d.

Weight Calculator; being a Series of Tables upon a new and comprehensive Plan, exhibiting at one Reference the exact Value of any Weight from 1 Pound to 15 Tons, at 300 progressive Rates, from 1 Penny to 168 shillings per cwt., and containing 186 000 direct Answers, which with their Combinations, consisting of a single Addition (mostly to be performed at Sight), will afford an Aggregate of 10 266 000 Answers. Henry Harben. New ed., carefully rev. London. 8vo. *Lockwood & Co.* 30s.

Weights, &c. 9th Report of Warden of Standards. (Parliamentary Report.) London. 8vo. 3d.

—— Measures and Money of all Nations, compiled by F. W. Clarke. New York. 12mo. (*Van Nostrand.*) $1.50.

Woods and Forests. 53d Annual Report. Parliamentary. London. 8vo. 2s. 6d.

Writing, Origin and Progress of —— as well hieroglyphic as elementary; illus. by Engravings taken from Marbles, Manuscripts, and Charters, ancient and modern; also Account of the Origin and Progress of Printing. Thomas Astle. London. 4to, illus. *Chatto & Windus.* (Announcement.)

Year Book, Everybody's —— 1876, a useful and popular Annual, containing Something for Everybody all the Year Round. London. 12mo. *Wyman,* 6d.

Zoology and Geology of Persia. W. T. Blanford; with Narratives of Travels by Majs. Lovett, St. John, and Evan Smith, and an Introduction by Sir Frederick Goldsmid; new ed. London. 2 vols. 8vo, illus. *Macmillan & Co.* (*New York.*) (Announcement.)

— —— for Students: a Hand-book—C. Carter Blake, with Preface by Richard Owen. London. 8vo. *Daldy & Ibister.* 7s. 6d.

ADDITIONS TO

LIBRARY AND MUSEUM.

DONATIONS ARE ACKNOWLEDGED AS FOLLOWS:

From R. C. Bacot, Jersey City, N. J.:
Report of the Riparian Commissioners of New Jersey for 1875. Newark.

From A. S. Barnes & Co., New York:
Treatise on the Theory and Solution of Algebraical Equations. John Macnie. New York, 1876.

From G.W. R. Bayley, New Orleans, La.:
Annual Report of the Board of Health of Louisiana. 1874. New Orleans.
Report of the Levee Commission of Engineers of Louisiana. New Orleans, 1876.

From Arthur Beardsley, Swarthmore.:
Seventh annual Catalogue of Swarthmore College, with Minutes of 12th annual Meeting of Stockholders. Philadelphia, 1875.

From A. D. Briggs, Springfield, Mass.:
Seventh annual Report of the Board of Railroad Commissioners. January, 1876. Boston. (2 copies.)

From John C. Campbell, New York:
Regulations establishing a Scale of Water Rents for the city of New York, by order of Commissioner of Public Works. 1875.

From Joseph P. Davis, Boston, Mass.:
Annual Report of the City Engineer for 1876. Boston. (2 copies.)

From the Department of the Interior—Washington, D. C.:
Bulletin of the U. S. Geological and Geographical Survey of the Territories. Do. of the U. S. National Museum. Nos. 1 and 2.

From James B. Eads, St. Louis, Mo.:
Dedicatory Address at Opening of New Hall of Merchants' Exchange, in St. Louis, Mo., Dec. 21, 1875.

From Charles E. Emery, New York:
Report of Trial of Steam Machinery of U. S. Revenue Steamer "Gallatin," at U. S. Navy Yard, Boston, December, 1874, January, 1875. Washington.

From Albert Fink, Atlanta, Ga.:
Annual Report of the Louisville & Nashville R. R. Co. 1873-4 and 1874-5. Louisville.

From Clark Fisher, Trenton, N. J.:
The Fisher Rail Joint, Boston, 1875. (2 copies.)

From James B. Francis, Lowell, Mass.-
Life and Works of Count Rumford. Philadelphia. 5 volumes.

From S. T. Fuller, Philadelphia:
Thirty-eighth annual Report of the Philadelphia, Wilmington & Baltimore R. R. Co., for Year ending Oct. 31, 1875. Philadelphia.

From the Institution of Civil Engineers, London:
St. Gothard Tunnel. Daniel K. Clark. Excerpt from Minutes of Proceedings, Session 1874-5. Vol. XLIII. London.

From the Institution of Mechanical Engineers, Birmingham, Eng.:
Proceedings, November, 1875. Birmingham.

From Louis M. Knapp, Buffalo, N. Y.:
Seventh annual Report of the Buffalo City Water Works for 1875. Buffalo.

From Charles Latimer, Meadville, Pa.:
Report of Proceedings of Meeting of Road Masters of the Atlantic & Great Western R. R. at Meadville, Dec. 2d, 1875, with Appendix. Salamanca.

From Edward S. Philbrick, Boston:
Final Report of the Water Commissioners of the Town of Brookline, Boston, 1875.

From O. M. Poe, Washington, D. C.:
Navy Register of the United States, to January 1, 1876. Washington.
Official Army Register, January, 1876. Washington.

From William C. Potter, Supervising Architect, Washington, D. C.:
Annual Report of the Supervising Architect to the Secretary of the Treasury for 1875. Washington.

From W. Milnor Roberts, New York:
Proceedings of advisory Commission of Engineers convened by James B. Eads, to consider Plans for Improvement of Mouth of the Mississippi. New Orleans. 1875. (Several copies.)

From Fairman Rogers, Philadelphia:
Catalogue of the Rogers' Engineering Library of the University of Pennsylvania. July, 1875. Philadelphia.

From Welton & Bonnett, Waterbury, Conn.:
Eighth and Ninth Reports of the Board of Waterbury Water Commissioners for term ending Dec. 31, 1875. Hartford.

ANNOUNCEMENTS.

MEETINGS: The next *stated* meeting of the Board of Direction will be held Wednesday, March 1st, at 3 o'clock P. M., for the transaction of regular business.

The next *regular* meeting of the Society will be held Wednesday, March 1st, at 8 o'clock P. M., when ballots for members will be canvassed; a paper on the "Consumption and Waste of Water delivered by public Works," by James H. Harlow, C. E., of Boston, Mass., will be read, and other matters taken up.

The next *stated* meeting of the Society will be held Wednesday, March 15th, at 8 o'clock P. M., when excerpts from the note-book of Simeon S. Post, C. E., late Member of the Society, referring to early engineering questions connected with the New York & Erie R. R., will be read, and selections from correspondence with members presented; after the formal session, an hour will be given to conversation.

THE CENTENNIAL COMMISSION of the Society meets on Wednesday evening, at 8 o'clock, except when a meeting of the Society is held on the same evening—and then—immediately after the Society adjourns.

At the *regular* meeting of the Society, April 5th, the paper of Benjamin S. Church, C. E., of New York, "Notes and Suggestions on the Croton Water Works and Supply for the Future," will be discussed. Copies of the paper will be sent to applicants, who will take part in the discussion.

A PAPER HAS BEEN RECEIVED for presentation to the Society—since the last announcement—as follows:—

"Notes and Suggestions on the Croton Water Works and Supply for the Future." Benjamin S. Church, February 1st, 1876.

TESTS OF AMERICAN IRON AND STEEL.—A copy of the preamble and resolutions referring to the work of the U. S. Board to test American Iron, Steel and other metals, and asking an appropriation of $50 000 for future operations, which were adopted by the Board of Direction, February 9th (see pages 17 and 29), will be sent to each member of the Society, and he is requested to bring the same to the attention of Members of Congress with whom he may be acquainted.

THE INDEX TO VOLUME I OF PROCEEDINGS. From the large size of this number, issue of the Index is deferred until March.

LIST OF MEMBERS.

ADDITIONS.

BLUNDEN, HENRY D. [J.]..Ast. Eng., Erie R'y, New York.....February 3, 1876.
DARRACH, CHARLES G.....Ast. Eng., Philadelphia Water Dep't, Philadelphia, Pa..... ..... " 16, "
FORD, JAMES K.....Ch. Eng., R., W. & O. R. R., Oswego, N. Y.....March 1, "
FTELEY, ALPHONSE.....Res. Eng., Boston Water Works, South Framingham, Mass.....January 25, "
HERING, RUDOLPH.....Ast. City Eng., Philadelphia, Pa.... " 27, "
HILL, ALBERT B. [J.].....Ast. City Eng., New Haven, Conn....February 9, "
LONG, THOMAS JOHN [J.]..Ast. Eng., Dep't of Docks, 28 West 60th St., New York..... " 16, "
PETERSON, PETER A.....Ch. Eng., Water Works, Toronto, Canada.....January 27, "
PONTZEN, ERNEST [C. M.]..Civil Con'g Eng., Vienna, Austria....February 12, "
STRIEDINGER, JULIUS H....Ast. U. S. Eng., 33 West Houston St., New York..... " 7, "

CHANGES AND CORRECTIONS.

BAXTER, GEORGE S.....106 East 35th St., New York.
BISSELL, H.....Box 485, Lawrenceburg, Ind.
BLAND, GEORGE P.....3214 Woodland Ave., West Philadelphia, Pa.
BRUSH, CHARLES B.....40 Hudson St., Hoboken, N. J.
FORD, ARTHUR L.....Div. Eng., R. W. & O. R.R., Oswego, N.Y.
KNIGHT, WILLIAM B.....Care Am. Soc. Civil Eng., New York.
MCALPINE, CHARLES L.....Evening Post Building, New York.
POINIER, P. PORTER.....Cambridge, Mass.
SEARLES, WILLIAM H.....Div. Eng., N. Y. Canals, Rochester, N.Y.
SPIELMANN, ARTHUR.... ..40 Hudson St., Hoboken, N.J.
VAN WINKLE, EDGAR B....Eng. and Surveyor Street Openings, Dep't Public Parks, 11 East 45th St., New York.
WHITE, W. HOWARD.....Eng. N. Y. & N. E. R.R., 47 West Cedar St., Boston, Mass.

DECEASED.

ARTHUR, WILLIAM YOUNG [F. M.]..Late of Brooklyn,.....February 15, 1876.

American Society of Civil Engineers.

PROCEEDINGS.

Vol. II, March, 1876.

MINUTES OF MEETINGS.

(Abstract of such as may be of general interest to members.)

OF THE SOCIETY.

MARCH 7TH, 1876.—A regular meeting was held at 8 o'clock P. M.

The vote on admissions to membership was canvassed and the following declared elected :—Members, Messrs. John Collinson James of Kingston, Can., and J. Howard Johnson of Mollendo, Peru ; and Juniors, Messrs. Henry N. Francis of Providence, R I., and Edward H. Morrison of Boonton, N. J.

A paper, by James H. Harlow, C. E., of Boston, on the "Consumption and Waste of Water delivered by Public Works," was read and discussed ; a report on the "Progress of the Jetties at the South Pass of the Mississippi," made January 18th, was presented; an accompanying chart and profiles were examined by members ; attention was also called to a proposition before the House Congressional Committee on Banking and Currency to establish a science of money.

Charles Macdonald referred to the paper on the "New Portage Bridge," * and gave the results of a recent examination of the masonry underneath that structure, which showed that although the piers were strong enough to sustain the wooden bridge, they had sensibly yielded under the iron one, in consequence of the greater concentration of weight.

MARCH 15TH, 1876.—A stated meeting was held at 8 o'clock P. M.

A communication from J. Foster Flagg, of December 31st, referring to the fall of an iron bridge in Meadville, Pa., and one from Galen W. Pearsons of February 15th, describing a scale of the discharge of water in jets and from long mains, were read.

Robert L. Cooke described a new system of telegraphy, whereby facsimile messages are transmitted, exhibited specimens of dispatches of manuscript and drawings, and invited members to witness the working of the apparatus.

* Transactions, Vol. V, page 7.

Francis Collingwood made a statement of the quantity of masonry in the piers and anchorages of the East River bridge as compared with measurements of stone used.

Attention was called to the Note Book of Simeon S. Post, deceased Member of the Society, containing records which refer to engineering questions considered in the location and construction of the New York & Erie R. R., and extracts therefrom were read.

OF THE BOARD OF DIRECTION.

MARCH 1ST, 1876.—A stated meeting was held at 3 o'clock P. M.

Proposals for admission to the Society were considered, and other routine business transacted.

Reference was made to a "Bill to establish a Bureau of Architecture" in the Treasury Department, prepared by the Board of Trustees of the American Institute of Architects, and introduced in the House of Representatives, February 7th, and to a modification of the same, prepared by William C. Potter, Supervising Architect of the Treasury Department; copies of each were presented, and the matter referred to the Committee to secure National Recognition of the Society.

A resolution that By-Law, Section 3, be amended by inserting "*Mining Engineer or Mechanical Engineer*" after—"has graduated as Civil Engineer,"—with the question, what is meant by the term "Civil Engineer" was considered, and the whole referred to Messrs. Holley, Roberts and Bogart as a committee, to report to the Board what changes in regard to the matter should be made in the Constitution and By-Laws.

Henry R. Worthington, Thomas C. Clarke and Charles Bender were appointed a committee of the Society to confer with a committee of the American Institute of Mining Engineers, appointed at its meeting in Washington, to present the subject of technical education for discussion by the two associations, and at the Centennial.

A communication from William P. Shinn, of February 28th, relating to experiments on railway traction with the dynograph of P. H. Dudley of Cleveland, O., was presented and referred.

NOTES AND MEMORANDA.

THE CENTENNIAL COMMISSION OF THE SOCIETY.

A special meeting of the Commission on the Centennial grounds in Philadelphia was held February 26th, the room and gallery in the Main Exhibition Building assigned for its use during the Exposition were inspected, and the grounds and other buildings visited.

John Bogart, Henry Pettit and Thomas C. Clarke, were at this meeting appointed a committee to fit up the space of the Commission, to take charge of and distribute the objects presented for exhibition, and to arrange the details of their exhibition. It is important

that committee men and exhibitors should aid in this work, by promptly stating the kind and amount of space needed.

It is expected that the American Institute of Architects will occupy the room and gallery in the Main Exhibition Building adjacent to those of the Commission. Space elsewhere has been offered for the Metallurgical Exhibition of the Commission, should it be required.

The rooms of the American Institute of Mining Engineering, at 1123 Girard street, Philadelphia (and not Girard avenue, as stated in February Proceedings), will be opened April 1st.

John Bogart has accepted the appointment of Resident Secretary of the Commission, and entered upon the discharge of his duties.

At the meeting March 15th, it was stated that, by partial reports, subscriptions to the fund of the Commission already amounted to over $1 250.

The following is from a circular recently issued by the chairman of Sub-Committee—

ON SEWERAGE AND SANITARY ENGINEERING.*—It is desirable to present at the Exposition such drawings, models, photographs, reports, memoirs and other means of representing this subject as will tend to give to visitors a correct idea of the present state of our practice in regard to Sewerage and Sanitary Engineering generally, and also to furnish the means for writing a memoir, which shall serve as an exhaustive historical statement of the progress attained in these departments of engineering, for publication and preservation in convenient form.

If you can aid in any way in the objects sought by this Committee, you will confer a favor by communicating immediately with the Chairman or the Secretary. Any matter which will be of use in preparing memoirs will be duly credited, and though it is desirable to have such materials collected early, any that can be furnished during the Exposition will be gratefully received.

Plans, photographs, models or illustrations, in any form, intended for exhibition, should be forwarded as soon as possible, in order to secure their proper arrangement. A brief explanation should be attached.

You will confer a favor by sending any contribution, however small, that will further the object, and also by communicating with other persons who would be likely to assist, and inducing them to do so.

* J. Herbert Shedd of Providence, R. I., Chairman.

TESTS OF AMERICAN IRON AND STEEL.*

Action has been taken in approval of plans and work of the United States Board appointed to test Iron, Steel and other metals, by various bodies, as follows :—

AMERICAN IRON AND STEEL ASSOCIATION.†—A memorial to the Senate and House of Representatives of the United States of America in Congress assembled :

Whereas, The Executive Committee of the American Iron and Steel Association has been deeply interested in the results to be expected from the appointment of a Board of scientific gentlemen to test iron, steel and other metals, and therefore has viewed with satisfaction the appointment of such a Board, one year ago, under the authority of an Act of Congress, and the appropriation by Congress of $75 000 for the purpose of constructing a testing machine of large size and special adaptation to the requirements of the Board, and of meeting the expenses attending a work so comprehensive in its character ; and

Whereas, This Committee has ascertained that the Board has been carefully organized, and has performed a large quantity of work during the past year; that the testing machine is being very elaborately constructed, and is now nearly finished; that a competent chemist has been employed, and a perfect laboratory furnished for his use ; that data concerning many past tests of iron, steel, etc., hitherto neglected, have been collated, arranged and tabulated, and will soon be ready for presentation to the public; that such tests as could be made with the machinery accessible have been determined by the proper committees of the Board; and that as a consequence the appropriation made one year ago is now almost exhausted ; and

Whereas, The work of the Board to test iron, steel, etc., has been so well begun, and promises the accomplishment of such excellent results in the interest of all who manufacture and all who consume the metals needed in the useful arts, including the Government itself, which is interested in the construction of ships, chain cables, armor, ordnance, buildings, docks, light-houses, etc.; and

Whereas, The members of the Board are generally contributing their time and services without remuneration :

* Continued from page 30.

† Office in Philadelphia.

Therefore, This Committee is of opinion that the Board to test iron, steel, etc., should be continued, and should be sustained by a fresh appropriation of $50 000; and it therefore respectfully petitions Congress to make such appropriation.

LYCEUM OF NATURAL HISTORY, NEW YORK. —Extract from Minutes.

Resolved, That the Academy of Science considers the appointment of the U. S. Board for testing Iron and Steel and other materials as a very important step in the interests of science.

Resolved, That the Academy of Science of the City of New York tender to the Board their co-operation and sympathy.

Resolved, That a committee of three members of this Academy be appointed to co-operate with the Board, and that the President be added to the committee.

The President appointed T. Egleston, W. E. Dodge, Jr., and A. R. Leeds, a committee for that purpose.

SCHOOL OF MINES, COLUMBIA COLLEGE.*— Resolved at a special meeting of the Faculty of the School of Mines:—

That the Faculty of the School of Mines of Columbia College consider the appointment of the "Board for Testing Iron and Steel and other Metals," as one of the most important steps ever taken by the United States Government in the interests of metallurgical and engineering science.

That the Faculty extend to the Board their earnest sympathy in the work undertaken by them, and express the hope that they will be allowed to make their tests in the most complete and exhaustive manner.

OBERLIN COLLEGE.—The Faculty resolved:

That we are very much gratified that the United States Government has appointed a Commission for testing iron and steel, and appreciate highly the services which such a Commission is able to render to the industries of our country.

That we are in favor of giving to this Commission every facility for the thorough and elaborate prosecution of their important work, and hope that the Government will provide for its full completion.

UNIVERSITY OF WISCONSIN.—Resolution:

The scientific members of the Faculty of the University of Wisconsin, express their approbation of the wisdom of the General Government in providing for an extended series of tests on the strength of iron and steel. They also wish to record their approval of the appointment of the distinguished metallurgist who stands at the head of the Commission appointed for this purpose, and their hope that the experiments may be allowed to continue as long as any results of value are to be obtained.

SELECTIONS FROM CORRESPONDENCE.

FALL OF AN IRON BRIDGE.—A member in Meadville, Pa., communicates the following:

An accident occurred here, Monday, December 20th, which is another example of the advisability of some action by the Society, upon the question of proper strains and tests for bridges. Two spans, about 128 feet in length each, of an iron bridge across French creek, had just been erected under a contract with the Board of County Commissioners. The bridge is an exceedingly slight one, and the workmanship appears to correspond.

The false work was taken away from the second span on Saturday, and Monday morning, while the workmen (some 10 to 12) were engaged in finishing it—the flooring not yet being on the bridge—the structure fell, killing one man, breaking the limbs of one or two, and injuring several besides.

From the best information that can be obtained, the pin that connected the diagonals with the upper chord at the end of one truss gave away, causing the immediate fall of that truss, which naturally drew the other after it.

I visited the wreck of one span of the bridge soon after its fall, and struck with the general lightness of the trusses, wrote to the Board of Commissioners, stating that the remaining span appeared very slight for the duty it might have to perform, necessitating at least a superior quality of iron, and in view of the fall of the other span, with no load upon it, rendering the quality quite questionable, recommended that samples should be taken from some of the broken bars, and sent to a qualified person to properly prove in a testing machine, but no action was taken.

Since then, I ascertained the principal dimensions of the bridge and of most of its members, and made a strain sheet; assuming a load of 10 pounds per square foot for snow, and a maximum additional or *live* load of 60 pounds per square foot, I find that in nearly all the members, the strain upon the metal per square inch would exceed the proper limit; in many of them going 50 per cent. beyond, and for one set of members would be almost double what it should be. Worst of all, however, the central pin of lower chord would have a strain 2¾ times what it should be called upon to bear, supposing the pin to be fitted in the best manner, which is doubt-

ful; whence the load which could be placed upon the bridge so that the strain upon none of its members should exceed the proper limit, is only 16 instead of 70 pounds, per square foot.

With regard to defects of construction, I noticed the lower chord in one panel had only four-fifths the metal of the adjoining one, in which the strain was identically the same; in several panels, the two main diagonals were quite unequally strained, thus making one of them bear a greater part of the load. In one panel, the entire strain comes upon one diagonal, thus doubling the load it has to carry; in another panel, the diagonals have slipped together, or were originally placed together on the pin running through the top chord, bringing thus an excessive and dangerous strain upon the pin.

I have not been able to ascertain the cause of the failure of the fallen span. There was no load upon it that could possibly have produced the disaster from undue strain, if the quality of the iron was good. One pin of defective iron would have been sufficient to produce the result, or the workmen may not have had the lateral bracing in place entirely, so that the trusses fell over sidewise.

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

Alcohol, a Course of Cantor Lectures delivered before the Society of Arts. Benjamin W. Richardson. New York, 12mo. *National Temperance So.* $1.00.

Architecture, Encyclopædia of—: historical, theoretical and practical. Joseph Gwilt, new ed., rev. with Alterations and Additions in Text by Wyatt Papworth, and Engravings by O. Jewett. London. 8vo, illus. *Longmans.* 52s. 6d.

—— Notes on the Churches of Derbyshire. Charles Fox. Vol. I. London. 8vo. *Bemrose.* 15s.

—— Suburban Homes — how to obtain them. Towndrow's new and comprehensive Plan of Association, by which Persons of limited Means may acquire desirable suburban Homes. New York. (*Van Nostrand.*) 12mo, illus. $0.50.

Armed Strength of Italy. Translated from the German for the Intelligence Branch of the Quartermaster-General's Department, Horse Guards, War Office, by Lieut. W. A. H. Hare. (English Government Publication.) London. 5s. 6d.

Artillerists' Hand-book of Reference. G. Will and J. C. Dalton. London. 8vo. *Clowes.* 7s. 6d.

Art, its Laws and the Reasons for Them, collected, considered and arranged for general and educational Purposes. Samuel P. Long *New ed., rev. and imp.* Boston. 8vo, illus. *Lee & Shepard.* $2.00.

Black Hills, a minute Description of the Routes. Scenery, Soil, Climate, Timber, Gold, Geology, Zoology, etc. Col. Dodge. New York. 12mo, illus. *Miller.* $2.00.

Botany, British wild Flowers, considered in relation to Insects. John Lubbock. London. 12mo, illus. (*Van Nostrand, New York.*) $1.50.

—— Elements of— for Use of Schools. John Hutton Balfour. 3d ed. Edinburgh. *Black.* 3s. 6d.

—— Historia Filicum, an Exposition of the Nature, Number and Organography of Ferns, and a Review of the Principles upon which Genera are founded and the Systems of Classification of the principal Authors, with a new general Arrangement; Characters of the Genera: Remarks on their Relationship to one another; their Species; Reference to Authors; Geographical Distribution, etc., etc. John Smith. London. 12mo, illus. *Macmillan.* (*New York.*) $6.25.

Builders' Prices. 1876. Skyring. London. 8vo. *Simpkin.* 4s.

Calculator, Iron and Steel Trades.—J. Aspin. imp. ed. London. 8vo. *Turner.* 12s.

Canals, annual Report of the State Engineer and Surveyor on the Canals of the State of New York for year ending September 30, 1875. Albany. 8vo, with maps.

Catalogue, the London— of Periodicals, Newspapers and Transactions of various Societies, with a List of Metropolitan Printing Societies and Clubs for 1876. London. 8vo. *Longmans.* 1s.

Cavalry, Organization and Tactics of the Cavalry Divisions. Maj. Gen. Walker. London. 12mo. *Blackwood & Sons.* 2s.

Chemistry, Class Book of— on the Basis of the new System. Edward L. Youmans, re-written and rev. New York. 12mo, illus. *Appletons.* $1.75.

—— Introduction to inorganic—. Wm. George Valentine. 3d ed. London. 8vo, illus. *Churchill.* 6s. 6d.

Chemical Analysis, Manual of qualitative—. William Dittmar. Edinburgh. 8vo, illus. *Edmanston.* 5s.

—— —— qualitative Chemical Analysis. C. R. Fresenius. 9th ed. trans. from 14th German ed. by A. Vacher. London. 8vo, illus. *Churchill.* 12s. 6d.

Civil Engineer, Address on the Education of— delivered by C. Graham-Smith, at the Opening Meeting of the Edinburgh and Leith Engineers' Society, November 3d, 1875. London. 8vo. *Spons.* (*New York.*) $0.60.

Coal Mining. Mining Engineering, a practical Treatise on Coal Mining. George G. Andre. No. 10. London. 4to, illus. *Spons.* (*New York*) $2.00.

Coast Survey, Report of the Superintendent of the U. S. Coast Survey, showing the Progress during the year 1872. Washington. 4to, with charts.

Colorist, the textile—, a monthly Journal of Bleaching, Printing, Dyeing and furnishing textile Fabrics, and the Manufacture and Application of Coloring Matters. Ed. by Charles O'Neill. *Palmer & Horne.* Manchester. 8vo, illus. (*New York, Wileys.*)

Culture; on self—, intellectual, physical and moral. John Stuart Blackie. 8th ed. Edinburgh. *Edmonston.* 2s. 6d.

Drainage, sanitary— of Houses and Towns. George E. Waring, Jr. 8vo, illus. New York. *Hurd & Houghton.* (Announcement.)

Drawing, Charcoal—. transl. from French of Auguste Allonge, with Introd. by C. C. Perkins. New York. 4to, illus. *Hurd & Houghton.* $0.75. (Announcement.)

Engraving, Wonders of—. George S. Duplessis. New York. 12mo, illus. *Scribner, Armstrong & Co.* $1.50.

Electrical Society; Journal of the American ——— ——, including original and selected Papers on Telegraphy and electrical Science. No. 1, Vol. I. Chicago. 8vo. (*Van Nostrand, New York.*) $1.50.

——— Testing, Hand-book of—. H. R. Kempe. London. 12mo. illus. *Spons.* (*New York.*) $2.

Filth Diseases and their Prevention. John Simon. 1st Am. Ed. printed under the Direction of the State Board of Health of Mass. Boston. 12mo. *Campbell.* $1.00.

Fires in Theatres. Eyre M. Shaw. London. 8vo. *Spons.* (*New York.*) $0.40.

Furniture, Sketches of artistic—, manufactured by Collinson & Lock. London. 4to, illus. (*Van Nostrand, New York.*) $5.25.

Gas Works, Transfer of—— —, to local Authorities, &c. A. Silverthorne. rev. ed. London. 8vo. *Lockwood.* 2s. 6d.

Geology. The Childhood of the World. E. Clodd. new ed. London. 8vo. *Henry S. King.* 1s.

Guide-Book to Philadelphia (Official). Thompson Westcott. 16mo, pp. 500. Philadelphia. 16mo, maps and engravings. *Porter & Coates.* (Announcement.) $1.50.

Guides. Riverside centennial Guides, in English, French, German and Spanish:—Boston to Washington, containing complete Information regarding Boston, New York, Philadelphia, Baltimore, Washington and the Centennial Exhibition, with many valuable Facts for Travelers and local Visitors; with map. $1. New York, and how to see It; $0.35. Philadelphia and the Centennial—how to see Them; $0.35. Washington, and how to see It; $0.35. New York. *Hurd & Houghton.* (Announcement.)

Habitations of Man in all Ages. Viollet Le Duc (Eugene). transl. by Benjamin Bucknall. London. 8vo, illus. *Low.* (*Osgood, Boston.*) $6.00.

Hand Railing, the sectorian System of—— —, a new Work elucidating the whole Subject by plates, with letterpress and notes. Wm. Forbes. Richmond. 4to. *Randolph & English.* (Announcement.) $3.00.

Hygiene, a Dictionary of ———, and public Health, comprising sanitary Chemistry, Engineering and Legislation, the dietetic Value of Foods, and the Detection of Adulterations; on the Plan of the Dictionnaire D'Hygiene Publique of Professor Ambroise Jardien. Alexander W. Blythe. London. 8vo. *Griffen.* 28s.

Insects Guide to the Study of—, and a Treatise on those injurious and beneficial to Crops. A. S. Packard. Jr. 5th ed. New York. 8vo, illus. *Holt.* $5.00.

Kinematics and Kinetics, an elementary Treaties on—. E. J. Gross. London. 12mo, illus. *Rivingtons.* 5s. 6d.

Lace, Honiton, Guide to Making—. Boston, 12mo. *Symons.* (Announcement.) $0.50.

Meteorological; the Penland Meteorological Circular and Weather Report. Ed. by S. H. Miller. 1874-5. Wisbeach. 8vo. *Leach.* 7s. 6d.

Military Engineering, Instruction in—— ——. Vol. I, Part 3, Military Bridges, compiled at the School of military Engineering, Chatham. London. 12mo, illus. (*Van Nostrand, New York.*) $2.00.

Mines and Mining, Statistics of—— ——, in States and Territories west of the Rocky Mountains, being the 7th annual Report of R. W. Raymond, U. S. Commissioner of Mining. Washington. 8vo, illus. (*Van Nostrand, New York.*) $3.00.

Navy, Report of the Secretary of Navy, for 1875. Washington. 8vo.

Notes and Queries. 5th series. Vol. 4. 4to. *Office.* 10s. 6d.

Ordnance, annual Report of Chief of —— (War Department) for year ending June 30th, 1875. S. V. Benet. Washington. 8vo, illus.

Paper Mills Directory of England, Scotland and Ireland, for 1876. London. 8vo. *Kent.* 2s. 6d.

Philosophy, History of ———, from Thales to the present Time. Frederick Ueberweg, trans. from 4th German ed. by George S. Morris, with Additions by Noah Porter. 2 vols. Vol. 1. Ancient and Mediæval Philosophy. Vol. 2. Modern Philosophy. New and cheaper ed. New York. 8vo. *Scribner, Armstrong & Co.* $5.00.

Philosophy without Assumptions. Thomas P. Kirkman. London. *Longmans.* 10s. 6d.

Quaternions, an elementary Treaties on ——. P. G. Tait. 2d ed. London. 8vo. *Macmillan.* (*New York*). $7.00.

Railway, the Midland ———, its Rise and Progress: a Narrative of modern Enterprise. Frederick S. Williams. London. 8vo. *Strahan.* 26s.

Seamen's Annual for the home and foreign Trade: containing a complete List of Lights, Buoys, Rocks and Shoals, issued during 1875; useful in correcting Charts and sailing Directions; Abstract of Board of Trade Notices, &c. Edi. by W. H. Rosser. London. 8vo. *G. Wilson.* 2s.

Science and Industry, Annual Record of ——, for 1875. Spencer F. Baird. New York. *Harpers.* (Announcement.)

——— Popular Science Review. Vol. 14. London. 8vo. *Hardwicke.* 12s.

Ship, History of —— from her Cradle to her Grave. London. 3d. ed. 16mo. *Tegg.* 5s.

Shipping, History of Merchant — and ancient Commerce. U. S. Lindsay. 4 vols. Vols. 3 and 4. London. 8vo. *Low.* Each, 24s.

Steam Fire Engines, Hand-book of modern —— —— ——, including the Running, Care and Management. Stephen Roper. Philadelphia. *Claxton, Remsen & Haffelfinger.*

Surveying for India, Manual of—H. L. Thurlier and N. Smith. 3d. ed. London. 8vo, illus. *Taacner.* 42s.

Telegraph Code. International Mercantile —— ——, compiled for the use of Bankers, Merchants, Manufacturers, Contractors, Brokers, Shipowners, &c., and their Agents, by author of "General Telegraph Code." London. 8vo. (*Van Nostrand, New York.*) $12.50.

Workshop Manipulation. Economy of—a Logical Method of Learning constructive Mechanics. J. Richards. London. 8vo, illus. *Spons* (*New York.*) $2.00.

Writing, the Origin and Progress of ———. London. 4to. illus. *Chatto & Windus.* 35s.

Year Book of Facts, in Science and the Arts, for 1875. Ed. by Charles W. Vincent. London. 12mo. *Ward & Lock.* 2s. 6d.

Zoology, comparative—. Prof. Orton. New York. 8vo, illus. *Appletons.* (Announcement.)

ADDITIONS TO

LIBRARY AND MUSEUM.

DONATIONS ARE ACKNOWLEDGED AS FOLLOWS:

From R. L. Cooke, New York:

Fac-simile copy of the Map of "Neutral Ground between White Plains and Kingsbridge," used by Gen. Washington during the Revolutionary War; framed.

From C. Davis, Alleghany City, Pa.:

Annual Report of Comptroller of Alleghany, for 1874, and Reports of Departments. Pittsburgh, 1875.

From Prof. J. E. Hilgard, Washington:

Report of Superintendent of United States Coast Survey, showing Progress of Survey during 1872. Washington, 1875.

From Gen. A. A. Humphries, Chief of Engineers, U. S. A., Washington, D.C.:

Annual Report of the Chief of Engineers to the Secretary of War for 1875. In 2 parts. Washington.

Also communications from the War Department (each 2 copies) relating to:—appropriation for Prosecution of Work at Mouth of Cape Fear River; the Harbor of Charlevoix, Michigan; the Improvement of Detroit and Harlem Rivers, and the Condition of Harbor of Refuge at Mouth of Sturgeon Bay Ship Canal, Wisconsin; the Leak in High Service Reservoir, Washington, D. C.; and transmitting Reports;—of S. T. Abert on Surveys of the Eastern Branch of Potomac River, and of other Rivers and Harbors; of Board of Engineers on channel between Staten Island and New Jersey; of C. E. Blunt on Harbor of Vermillion, O.; of the Chief of Engineers upon Extension of Navigation from Chesapake Bay to Pamlico Sound; the Improvement of Ship Channel between Mouth of San Jacinto River and Bolivar Channel, Galvaston Harbor; and on Removal of Obstructions to Navigation of Mississippi River near Fort Madison and Burlington, Iowa; of W. P. Craighill, on Survey of Elk River, West Va.; of F. U. Farquhar, on Survey of Chippewa River, Wis.; of G. L. Gillespie, on Canal to connect Wabash River and Lake Michigan; of D. C. Houston, on Improvement of Racine Harbor, Wis.; of W. E. Merrill, on Survey of Monongahela River, &c.; of J. H. Simpson, on Survey of Mississippi River between St. Louis and Cairo; of G. Thom, on Survey of Martinius Island Harbor, and Belfast Bay and Harbor, Maine, and Ipswich Bay and Harbor, Mass.; of G. K. Warren, on Survey of Little Narragansett Bay, R. I.; of G. Weitzel, on Louisville and Portland Canal Co., and on Saginaw River, Thunder Bay, Clinton and Au Sable Rivers, Mich.; and of J. M. Wilson, on Survey of the Mouth of Big Sandy Creek, N. Y.

From W. J. McAlpine, Albany, N.Y.:

Report on the Water Supply of Philadelphia, by the Commission of Engineers. Philadelphia, 1875. (Copies for distribution.)

Water Works Reports, 1853, one volume.:

Supply of Water to the Metropolis, Appendix. No. III. Reports and Evidence—medical, chemical, geological and miscellaneous. London. 1850.

Report of the Water Commissioners of Hoboken and Jersey City. 1852.

Report of Survey of the best source for obtaining a Supply of pure Water for Charleston. 1853.

Report on preliminary Survey for Water Supply of Montreal. By Thomas C. Keefer. 1852.

Report for supplying Rochester with Water from Various Sources. By Stuart & Marsh. 1853.

Report of Water Committee on the Petition of A. McQuade and Others, relative to Contract for excavating Trenches for Water Pipes. Albany. 1851.

Report of the Superintendent of the Water Works. Albany. 1854.

Report of Committee on Water and Communications of W. J. McAlpine and J. B. Jervis on Water for Brooklyn. 1851.

Report to Water Committee of Brooklyn, April 15th, 1852, on Supplying the City with Water. By William J. McAlpine.

Communication of Edward A. Lambert, Mayor of Brooklyn, to the Common Council. January 3d, 1853.

Annual Message of Mayor of Brooklyn, January, 1854.

Report of Water Commissioners of Chicago, December 8, 1851.

Analyses of Water in Vicinity of Cincinnati. By John Locke, M. D., and Joseph N. Locke. 1853.

3d Semi-Annual Report of Water Commissioners. Chicago. 1853.

Report of Cochituate Water Board for 1852. Boston.

Annual Report of watering Committee of Philadelphia for 1852.

Report of Lieut. Meigs, with Surveys, Plans and Estimates, for Supplying Washington and Georgetown with Water.

The following are in French:

Completion of the Sewers and Employment of their Waters. Paris. 1871.

Distribution of Water in Egypt and Greece. M. Belgrand.

Fall of Waters of the Basin of the Seine in the Summer and Fall of 1874-5. E. Belgrand and G. Lemoine, (2 pamphlets).

Hydrometric Service of the Basin of the Seine. Observations made in 1871, 2, 3. By M. G. Lemoine, under Direction of M. Belgrand. 4 vols. Paris. 1873-4.

Memoirs of the Inspector General; the Sewer of Boudy.

Monthly Meteorological Bulletin of the Scientific Association of France. Dec., 1871, to Nov. 1873. 2 vols. Paris.

Papers read before the Academy of Sciences; on Rising of the Waters of the Seine and its Tributaries; Sources of the Basin of the Seine, Hydraulic Studies—the Seine; Condition to be sought in Determining the Sources for supplying Paris with Water, and Hydrometric Service on the Basin of the Seine. By M. Belgrand.

Peat in the Valley of the Seine. M. Belgrand.

Principal Rivers of the North, Centre and South of France. M. Belgrand.

Report of Committee on Water, with Reports of Engineers on new Aqueducts of Montreal. 1854.

Subterranean Works of Paris. Preliminary. 2 vols.
System of Rains and Current of Water in Basin of the Seine during the quaternary Epoch. M. Belgrand.
Water Courses of the Valley of the Vanne. Paris. 1871.
Water.—Roman Aqueducts. M. Belgrand. Paris. 1873 and 1874.

From Mrs. S. S. Post, Jersey City, N.J.:
Manuscript Note Book of the late Simeon S. Post, C. E., containing Reports and Data relating to the Construction of the New York and Erie RR.

From Alfred F. Sears, Piura, Peru:
Annals of national Corps of Engineers of Peru. Vols. I, II. Lima. 1874. (Spanish.)

From Admiral B. F. Sands—Superintendent U. S. Naval Observatory—Washington, D. C.
Astronomical and MeteorologicalObservations made during 1873, at the U. S. Naval Observatory. Washington, 1875.

From W. Sooy Smith, Maywood, Ill.:
Annual Report of the Supervising Architect to the Secretary of the Treasury for 1875. Washington.

From Robert H. Thurston, Hoboken, N. J.:
Circular of The Globe Rolling Mill Co. (Several copies.)
Necessity of a mechanical Laboratory; its Province and Methods, by R. H. Thurston. Philadelphia. 1875. (Copies for distribution.)

From D. Van Nostrand, New York:
Catalogue of American and Foreign Scientific Books. 20th ed. New York,—(Copies for distribution.)
Van Nostrand's Science Series:—
Chimneys for Furnaces, Fire-places and Steam Boilers. R. Armstrong. 1873.
Steam Boiler Explosions. Zerah Colburn. 1873.
Practical Designing of retaining Walls. Arthur Jacob. 1873.
Proportions of Pins used in Bridges. Charles Bender. 1873.
Ventilation of Buildings. W. F. Butler. 1873.
Designing and Construction of Storage Reservoirs. Arthur Jacob. 1873.
Surcharged and different Forms of Retaining Walls. James S. Tate. 1873.
Short Treatise on the Compound Steam Engine. John Turnbull, Jr. 1874.
Fuel. C. William Siemens. The Value of Artificial Fuels as compared with Coal. John Wormald. 1874.
Compound Engines. Trans. from French of A. Mallet. 1874.
Theory of Arches. W. Allen. 1874.
Practical Theory of Voussoir Arches. William Cain. 1874.
Practical Treatise on Gases met with in Coal Mines. J. J. Atkinson. 1875.
Practical Treatise on Friction of Air in Mines. J. J. Atkinson. 1875.
Skew Arches.—Advantages and Disadvantages of different Methods of Construction. E. W. Hyde. 1875.
Graphic Method for Solving certain Algebraic Problems. George L. Vose. 1875.
Water and Water Supply. W. H. Corfield. 1875.
Sewerage and Sewage Utilization. W. H. Corfield. 1875.
Strength of Beams under Transverse Loads. W. Allen. 1875.
Bridge and Tunnel Centres. John B. McMaster 1875.
Safety Valves. Richard H. Buel. 1875.

From Francis H. Vinton, New York:
Catalogue of the Officers and Students of the School of Mines of Columbia College, New York, 1874-5.

From Henry D. Whitcomb, Richmond:
Annual Report of the James River Improvement Committee, transmitting Report of their Engineer, January, 1876.

From Joseph M. Wilson, Philadelphia:
Drawings and Plans of Centennial Buildings at Philadelphia. Lithographic sheets.
Specimen of Timber and Iron from various Parts of the old Trenton Bridge—in use since 1805.

From William W. Wilson, Yonkers, N.Y.:
Third Annual Report of Board of Yonkers Water Commissioners. December, 1875. New York. (Copies for distribution.)

From William E. Worthen (of Committee of Experts), New York:
Reports on the Trials of Pumping Engines, Milwaukee Water Works. 1875. (A copy for each member.)

From H. R. Worthington, New York:
Memorial of the Opening of the N. Y. & Canada R'y. New York, 1876.

From Miscellaneous Sources:
By-Laws of the Union of German Architect and Engineer Societies. Berlin. 1872. (German.)
Paris Universal Exhibition of 1867—Catalogue of the British Section—with a statistical Introduction and an Appendix. London. 1867.
Plan of the City of New York and Environs. Surveyed in 1766 and 1767.
Proceedings of General Meeting of the German Architect and Engineer Societies at Berlin. Sept. 23d to 26th, 1874. Berlin. (German.)
Proceedings of Railway Conductors' Association. Eighth International Convention in New York. October 27th, 28th, 1875. Official Report. Columbus.
Reference Catalogue of current Literature. New York. 1875. F. Leypoldt.
Reports of the Society of Universal Knowledge at Dresden. 1875. (German.) 2 numbers.
Rules and Regulations—for running Trains and the Government of Employes on the following Railroads (each one volume):
Atlantic & Great Western R. R. July 1, 1872. Meadville.
Cleveland & Pittsburgh R. R. Nov. 14, 1870.
Erie Ry. Oct. 1, 1866. New York.
Lake Shore & Michigan Southern Ry. Co. Cleveland. 1875.
Michigan Central Railroad Co.'s Instructions for working Telegraph Lines. April 1, 1866. Detroit.
Pennsylvania R. R.—including the Substance of General Orders issued previous to April 1, 1864. Altoona.
Philadelphia & Reading R. R.—for Conductors of Coal and Freigh Trains. Philadelphia. 1866.
Specifications and Drawings of Patents issued from the U. S. Patent Office for July, 1875. Washington.

ANNOUNCEMENTS.

MEETINGS: The next *stated* meeting of the Board of Direction will be held Wednesday, April 5th, at 3 o'clock P. M., for the transaction of regular business.

The next *regular* meeting of the Society will be held Wednesday, April 5th, at 8 o'clock P. M., when ballots for members will be canvassed; the paper by Benjamin Church, C. E., of New York,—"Notes and Suggestions on the Croton Water Works and Supply for the Future,"—discussed; Prof. Robert H. Thurston, of Hoboken, N. J., will explain the construction and workings of Dudley's dynograph (referring to the measurement of railway traction), and other matters will be taken up.

The next *stated* meeting of the Society will be held Wednesday, April 19th, at 8 o'clock P. M., when Robert L. Cooke, C. E., of New York, will read a paper on the "History of the Lehigh Coal and Navigation Co.," and selections from correspondence received will be presented; after the formal session, an hour will be given to conversation.

At the *regular* meeting of the Society, May 3d, a paper will be presented on "Engineering Services, their Value and Compensation."

THE CENTENNIAL COMMISSION of the Society meets on Wednesday evening, at 8 o'clock, except when a meeting of the Society is held on the same evening—and then—immediately after the Society adjourns.

A PAPER HAS BEEN RECEIVED for presentation to the Society—since the last announcement—as follows:—

The Theory of continuous Girders in Relation to Economy in Bridge Building—Charles Bender, March 9th, 1876.

AMERICAN TUNNELLING. — Mr. Henry S. Drinker, Mining Engineer, is engaged in preparing a general treatise on this subject.

No work of the kind has ever been compiled in America, and the principal English record is Mr. Simm's account of the method adopted in constructing two tunnels in 1844.

Whenever a new tunnel is started, the engineer is generally put to much trouble in looking up records of preceding work, so as to determine on the most advisable cross-section to adopt, if in rock, and what thickness of masonry has been deemed advisable in soft ground, what rate of progress has been attained in various materials, and at what cost, &c., &c. Except in the case of a few isolated papers read before engineering societies, there are no authentic printed records attainable.

To the practical record of American work will be added a condensed history of European tunnelling, with tables showing location, length, cost, rate of driving, machinery used, &c., &c. Returns of South American work have also been applied for.

Engineers throughout the country are asked to assist in collecting data, and to forward facts in their possession relating to tunnel construction. If desired, manuscripts and drawings will be returned. The Secretary will send to applicants a circular giving a general scheme of the subjects to be treated.

DONATIONS TO THE LIBRARY.—Members and others are asked to contribute regularly to the library of the Society, copies of government, municipal, railway, canal and other reports, specifications, profiles, maps, photographs and like matter, making up the record of engineering operations for the past or present, and to inform the Secretary where such may be had. Duplicate copies are desired, for transmission to foreign societies in return for works collected and sent to this library by them; also for exchange with members and others who wish complete sets referring to particular subjects. In order to gather material now considered of but little value, but of great future importance in the history of the public works of this country and a comparison of their economical results, donations are solicited of old reports or pamphlets, which in any way refer to their construction or operation.

PAPERS FOR THE NORMAL MEDAL should be presented before September 1st next. The conditions of award are set forth in the Code of Rules heretofore published in Transactions; a copy will be furnished to applicants.

PHOTOGRAPHS OF MEMBERS.—By resolution of the Society, each member has been requested to furnish two photographs of himself, of the usual card size, as a means of promoting social recognition and intercourse. Those who have not complied with this request are specially asked to aid in making the collection complete, by speedily forwarding their photographs, endorsed with autograph and date.

Members—particularly those from out of town—are invited to make the rooms of the Society their headquarters. Appointments with other parties may be kept here; and for such, and similar personal matters, a private room can now be had.

LIST OF MEMBERS.

ADDITIONS.

FRANCIS, HENRY N. [J.]...Ass't Eng., Water Works, Providence, R. I.....March 8, 1876.
JAMES, JOHN C.....Res. Eng. Grand Trunk R'y, Kingston, Can... ..... " 25, "
OPDYKE, STACY B., JR....Ass't Eng., P. R. R., Philadelphia, Pa. " " "
STAATS, ROBERT P. [J.]..Ass't Eng., Dep't of Docks, New York, " " "

CHANGES AND CORRECTIONS.

BOGUE, VIRGIL G. .....256 Ryerson St., Brooklyn, N. Y.
BURNHAM, GEORGE, Jr.....2211 Greene St., Philadelphia, Pa.
CISNEROS, FRANCIS J.....303 West 33d St., N.Y.
COHEN, MENDEZ .....177 North Charles St., Baltimore, Md.
CORTHELL, ELMER L.....Ass't Eng. South Pass Jetty Works, Port Eads, La.
CURTIS, RUSSELL H.....707 Tremont St., Boston, Mass.
FOGG, CHARLES E.....P. H. & B. R. R., Poughkeepsie, N.Y.
FOSTER, WILBUR F.....Burns' Block, Nashville, Tenn.
HARRIS, CHARLES M.....61 Broadway, New York.
ILLSLEY, WILLIAM A.....128 La Salle St., Chicago, Ill.
KINSLEY, THOMAS P.....312 Madison St., Brooklyn, N.Y.
KNIGHT, WILLIAM B.....Box 5,707 (Post Office), New York.
LATCHA, JACOB A.....Jersey Shore, Pa.
MERIWETHER, NILES.....Road Master, N. O., St. L. & C R. R., New Orleans, La.
MERRIMAN, MANSFIELD....Box 519 (Post Office), New Haven, Conn.
OLNEY, L. F.....Franklin House, Buffalo, N.Y.
PEARSONS, GALEN W.....Ogdensburgh, N.Y.
PROUT, HENRY G.....Major Egyptian Army, Cairo, Egypt.
RADENHURST, WILLIAM N..N. Y. State Canals, Power's Building, Rochester, N.Y.
SMITH, CHARLES C.....35 West Vermont St., Indianapolis, Ind.
SOULERIN, LEON.....Inter-Ocean Building, Chicago, Ill.
STONE, AMASA B.....13 East 36th St., New York.

American Society of Civil Engineers.

PROCEEDINGS.

Vol. II, April, 1876.

MINUTES OF MEETINGS.

(Abstract of such, as may be of general interest to members.)

OF THE SOCIETY.

APRIL 5TH, 1876.—A regular meeting was held at 8 o'clock P.M.

The vote on admissions to membership was canvassed and the following declared elected:—Corresponding Member, Charles O. Gleim of Cologne, Prussia; Members, Augustus P. Barnard of New York; James D. Burr of Corrunna, Mich.; Samuel H. Chittenden of New Haven, Conn.; John E. Earley of Somerset, Ky.; John W. Hill* of Hamilton, O.; Charles Latimer of Meadville, Pa.; William H. McClintock of Louisville, Ky.; Charles MacRitchie† of Milwaukee, Wis.; Robert Moore of St. Louis, Mo.; John Nichol‡ of Milwaukee, Wis., and George Y. Wisner of Detroit, Mich.; and Juniors, Charles E. Billin of Philadelphia, Pa., and Edwin E. Glasken of New York.

A communication from George W. R. Bayley of New Orleans, dated March 31st, enclosing profile of South Pass bar, showing progress to that date, of improvement at the mouth of the Mississippi, and one from James B. Francis of Lowell, Mass., of the same date, referring to the failure of the dam of the Leicester reservoir of the Worcester water works, were read. Sketches accompanying the latter were examined, and an account of the failure was given, by John T. Fanning of Manchester, N. H.

Discussion of "Notes and Suggestions on the Croton Water Works and Supply for the Future,"§ was taken up. A communication from

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* Became Junior, February 12th, 1875.

† Became Associate, November 1st, 1872.

‡ Became Associate, November 4th, 1872.

§ Transactions. CXX, Benjamin S. Church.

James B. Francis, dated April 3d, and one from J. Herbert Shedd of Providence, R. I., dated April 4th, were read; the discussion was continued by Francis Collingwood, J. James R. Croes, Benjamin S. Church, Alfred W. Craven, Julius W. Adams and George S. Greene; and further discussion was postponed to the meeting, April 19th next., when a paper describing a "Water Conduit under Pressure," by John T. Fanning will be read.

Robert H. Thurston made some remarks upon the peculiarities of the two classes of metals referred to, in a "Note on the Strength of Materials as affected by Time," presented to the Society; and illustrated them by exhibiting typical strain diagrams, obtained by plotting the results of experiments on transverse strength, which were in progress at the Mechanical Laboratory of the Stevens Institute of Technology.

A bar of each class was represented, one of which exhibited the exaltation of the elastic limit under strain, while the other exhibited depression of the elastic limit and flow. A third bar was very elastic and brittle, and exhibited both flow and the depression of the limit of elasticity.*

He next took up the subject of railway traction, and referred to the Dudley dynograph as a means of determining the same, illustrating his remarks by exhibition of the graphic record obtained by use of this instrument.†

After consideration of the two subjects, the following were offered—and under the By-Law adopted January 5th, referred to the Board of Direction :—

Resolved, that a committee of three be appointed to examine and report upon the recent failure of the dam at Worcester, Mass., the same to be without expense to the Society.

Resolved, that a committee of five *(named in resolution)* be appointed to examine and report upon the resistance of railway trains; such to be without expense to the Society.

APRIL 19TH, 1876.—A stated meeting was held at 8 o'clock, P.M.

Robert L. Cooke, C.E., of New York, read a paper, giving the "History of the Lehigh Coal and Navigation Company, and its Works."

The discussion of "Notes and Suggestions on the Croton Water Works and Supply for the Future"‡ was continued from the last meeting; communications, from William R. Hutton, dated April 6th, and William J. McAlpine, dated April 18th, were read, and further discussion was postponed to the meeting May 3d next.

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* He proposed to present a note accompanied by *fac similies* of these typical strain-diagrams and referred to the fact that the discovery by himself of the exaltation of the elastic limit in torsion, by Com. Beardslee in tension, and again by himself in transverse strain of metals of the first class, seemed to indicate that the phenomenon was undoubtedly molecular.

† Page 50. ‡ Transactions. CXX, Benjamin S. Church.

OF THE BOARD OF DIRECTION.

APRIL 5TH, 1876.—A stated meeting was held at 3 o'clock P. M.: proposals for admission to the Society were considered and other routine business transacted.

A statement was made in regard to the action of the Board at a preceding meeting, relating to experiments on railway traction, and the same was reconsidered.

Mr. Holley, of the Joint Committee of the American Institute of Mining Engineers and of the Society, on Technical Education, reported that the committee had determined to consider the subject at a meeting of the two associations, in Philadelphia, June 20th, next, and to invite members and others familiar with the topic, to take part in its discussion.

Permission was given to the Centennial Commission to exhibit at the International Exposition, drawings, photographs and models of the Society, and an invitation was extended to foreign engineers, members of associations in communication with the Society, to attend the Eighth Annual Convention.

A session was held in the evening: the resolutions offered at the preceding meeting of the Society were presented and duly examined, reports of approval were prepared, and a ballot ordered.

BOOK NOTES.

GRAPHICAL STATICS.*—We have in the first of these two works, the author's treatment of his subject, the *elements* of graphical Statics; it is not designed to be a complete treatise; indeed, he clearly states that for many purposes—such as arithmetical operations, calculation and transformation of areas, and many more—this method, though developed for these uses by its votaries, does not meet with his approval.

Just how far it pays—to use the commercial term—to employ the graphical method in the pursuit of an engineering practice, and when or where it is more expedient to calculate as of old, is still an unsettled point among leaders in engineering science. But it is only some of those leaders who thus reason; the man of abstract science does not care whether he evolves from his studies something practical or no; he glories in "pursuing science for science's sake." Such an one, in the writer's opinion, is Culmann, the reviewer and to a great extent, the author of Graphical Statics, and such often do positive injury to the advance of art at least, if not of science, by spending their energy and of those who follow them, upon vast fields of work outside of our present every day needs and life; and, what is still worse, upon branches of science too often destined, like many before them, to blossom, but to "waste their sweetness on the desert air," without bearing fruit. It is too often forgotten how true this is, of many a branch of science that existed, flourished and now is buried in some musty volume; and so the search for the unknown goes on, unconfined by the doubt whether it be for a useful object. This will continue so long as the motive of many minds is simply to "pursue science for science's sake."

* Elements of graphical Statics and their Application to framed Structures, etc.; Cranes, Bridges, Roof and suspension Trusses, braced and Stone Arches, Pivot and Draw Spans, continuous Girders, etc., A. Jay Du Bois, New York. 2 vols. 8vo (500 pp. text, 32 double plates). *J. Wiley & Sons.* $5.00.

New Method of graphical Statics. A. Jay Du Bois. (Reprinted from Van Nostrand's Eclectic Engineering Magazine). New York. 8vo (80 pp. text, 4 folding plates). *D. Van Nostrand.* $2.00.

In this way Graphical Statics had its recent revival, and probably, for this reason its advance has been painfully slow; it has been encumbered by too much trash, and the student engineer in this country certainly owes thanks therefore, to Prof. Du Bois for having, in this work culled, from all that so far has been produced, the best and most useful results—a dainty dish to set before an engineer, a bit of stimulating and yet wholesome food to set before an engineering student.

It is not within the province of the writer to pursue this part of our notice further, and to discuss the cases in which Graphical Statics are better than calculation, or not as good. Minds of different original construction, as also those of the same original type, but developed under different systems of training, will find the one or the other method the best and easiest to follow in the solution of the same problem.

Besides treating the many principles of the graphical method, Prof. Du Bois discusses ably and lucidly the application of these principles to the calculation of the strains in all classes of simple girders; in continuous girders of constant cross-section; in what is gradually receiving the generic name of "braced" arches, when hinged at the crown and at the abutments, when hinged only at the abutments and when fixed at the abutments; to the construction of stone arches; and to finding the strains in suspension bridges of the various systems.

In treating of continuous girders, continuous draw-bridges, and the several kinds of braced arches, the author can not apparently resist the temptation to give the readers of only the English tongue, the latest and the best upon the analytical treatment also of these problems on which so much remains yet to be written to bring the American or English discussion of these subjects, more especially, to the height which it has attained in other countries.

The St. Louis bridge, at the same time the highest, and in the United States, an almost unique embodiment of the knowledge of the day on the subject of elastic arched bridges, receives full credit. Those engineers who have read with mingled pain, impatience and perhaps exasperation, the treatment accorded this wisely designed and no less wisely executed master-piece of modern engineering, in the discussion recently had upon it in Transactions, will here find much that will interest them, and which must tend to remove misunderstandings and instruct the minds of all upon a live subject in the bridge science of to-day. In an appendix, Prof. Du Bois treats directly of this disussion.

To return to a consideration of the fact that the method by calculation finds a place in many instances in this treatise, it would seem that the author is only to be commended for his fairness and impartiality in placing it there. In a union of the analytical and graphical methods, more or less of each, in the several cases of practice, will probably be found the method of solution that will most aid the engineer in the office or the mechanic in his workshop.

The second of these two works is contained in the first, and is, as will be seen by comparison of size, much abridged. C. H.

NOTES AND MEMORANDA.

Reports of Meetings.

Determination of the Resistance of Railroad Trains*.—During the past half century, comparatively little positive and experimental knowledge has been acquired in this department.

The resistance of a railroad train on a level track, amounting to 2 or 3 tons usually, is due to friction of various kinds, and "head resistance" caused by winds; the friction being rolling friction of the wheels and sliding friction of the axles, wheel-flanges and parts of the machinery when the locomotive is taken into account. This is often seriously increased by irregularity of the track and still more by rising grades. These elements have sometimes been determined and engineers are compelled to accept for all cases the formulas* of Harding and Russell, of D. K. Clark

* These are; $R=\left(6+\frac{V}{3}\right)T+\frac{AV^2}{400}$

$=\left(6+\frac{V}{15}\right)T+\frac{BV^2}{50000}$

in which A is area of frontage in square feet, B is volume in cubic feet, R is resistance and T is weight of train in tons, and V is speed in miles per hour.

Or, in pounds per ton,

including engine, $R=\frac{V^2}{171}+8$ and

excluding " $R=\frac{V^2}{240}+6$, whence for

$V=$ 10, 12, 15, 20, 25, and 30,
$R=$ 8.6, 8.8, 9.3, 10.3, 11.7 and 13.3.

* Remarks of Prof. Robert H. Thurston at meeting of the Society, April 5th, 1876.

and of Vuillemin, Guebhard and Dieudonne. Resistance on grades could be taken at about 0.45 pounds more per one foot rise per mile and 2.4 feet rise per mile corresponds to a degree of curvature; the resistance on a curve of 400 feet radius, as given by various authorities, being double that on straight line.

The recording dynamometers of Morin, of D. K. Clark, of F. B. Stevens and of William Froude, may be referred to as illustrating the use of recording instruments for determining traction-resistance. In these instruments, the record was made upon a ribbon of paper by a pencil traversing it laterally and producing a curve of which the ordinates were proportional to the force exerted; Morin introduced the use of a clock to make marks on the paper at regular intervals which enabled the speed to be determined by measuring the spaces, the paper having a motion derived from that of the wheels and proportional to the speed of the train.

Mr. P. H. Dudley has adopted an hydraulic cylinder, like Froude's, with an indicator attached to the piston of which the pressures in the hydraulic cylinder are transmitted by a small tube. The cylinder and its piston being attached, the one to the train, the other to the engine-tender, all tractive force is transmitted through the instrument, producing a pressure on the contained liquid equal to that employed in drawing the train. The indicator records this pressure upon the traveling paper, producing a diagram on which every variation of resistance is accurately shown. The paper is driven from the car-axle, provision being made to adjust its motion perfectly when the scale is changed by passing around curves. An electro-magnet, controlled by a clock, moves the pencil which makes the time mark. This instrument has been sometime in use on the Lake Shore & Michigan Southern R. R. A large roll of diagrams thus obtained is exhibited.

As will be noticed, the variation of resistance due to change in character of roadbed, to running from steel to iron rails and to change of grade, is very marked. The great superiority of steel rails, as here shown, due to their stiffness and uniformity, is remarkable. In one case, it was found that the economical mean rate of speed between termini for a train of 700 tons weight was nearer 18 than 12 miles per hour, a fact to be attributed, doubtless, to the peculiar grades of the road and to a more efficient distribution of steam in the engine. The work, done in hauling the train from Cleveland to Erie amounted to about 2 500 000 000 foot-pounds. It was concluded after several experiments that the economical rate of speed for such train drawn by such engines on that road was considerably above 12 miles an hour.

In another case, the resistances per ton were worked up, for light and for heavy trains. A loaded car weighing 29 tons gave 61.5; 49 tons gave 51.5; 107 tons 32.5; and 205 tons 26.5 pounds per ton; each on the same track. In long, heavy freight trains, weighing 700 or 750 tons, the resistance fell to, from 6.5 to 7 pounds. The resistance at 40 miles per hour of a passenger train of 5 cars, weighing about 90 tons, and carrying 15 tons, was 25 to 28 pounds. On a down grade of 16 feet per mile, the train just kept in motion without effort on the part of the engine.

The direction of the wind was noted by a dog-vane and it thus became possible to determine the law of its resistance and to check the ordinary formulas. It was found that the resistance to a train of closely set box-cars was much less than that to a train in which the cars were separated by brakemen's platforms.

The difference in the friction of journals not of the same length was well shown. The immense increase of strain on couplings due to the jerk on starting and to putting on the brakes was exhibited, amounting to several times that noted while in steady motion.

The attention of railroad engineers is called to the importance of these investigations; the American Institute of Mining Engineers has already appointed a committee to take up the subject and to endeavor to secure further investigation; the American Society of Civil Engineers, whose members are vastly more nearly concerned in such work, can greatly assist by appointing a committee to do similar work.

TESTS OF AMERICAN IRON AND STEEL.

At the meeting held in Washington, February 23d-25th last, the

American Institute of Mining Engineers took action as follows:

The committee appointed to co-operate with the United States Board for testing Iron and Steel and other Metals, reported that it had communicated with the Board, and that its services have been accepted with thanks. It has examined the plans proposed and finds them eminently judicious and likely to lead to the most important results in both metallurgical and civil engineering and the science of construction, and that they are likely to be of the greatest possible advantage to the United States government itself by furnish-

ing results which will both lessen the expense and increase the safety of naval, war and civil structures which the government has to undertake.

The Committee presented to the Institute the following preamble and resolution as one of the means of co-operation which will be likely to aid the labors of the Board.

Whereas, the Committee appointed by the American Institute of Mining Engineers to co-operate with United States Board for testing Iron and Steel and other Metals, has inquired into the plans proposed, and informed itself of the work already done by the United States Board, and has reported that the Board is, in its opinion, judiciously organized and that the plans show evidence of the highest professional ability ; and finds that the Board has already employed a competent chemist and equipped a chemical laboratory, where important results have already been arrived at ; that a very complete testing machine has been nearly completed under its direction, which is a model both of design and workmanship ; that it has already made a large number of experiments with the machines for testing now in use, and collected a large amount of information relating to tests made by different departments of the United States government and other competent bodies and persons; that it has prepared for a complete series of chemical and physical tests of iron and steel and of a number of alloys, which can but result in greater economy and durability of construction; that the members of the Board, who are men of the greatest professional ability and command the public confidence, are contributing their services gratuitously ; that the results to be attained are likely not only to benefit the world at large, but also to be of particular advantage to the United States government, by increasing the durability of the material which it is obliged to use, and cheapening the cost of construction of its naval, war, light-house and other structures; therefore—

Resolved, that this Institute heartily endorses the work of the Board;—that it is the opinion of this body that the United States Board for testing Iron and Steel and other Metals should be continued ;—that the Institute respectfully petitions the Honorable Senate and House of Representatives to grant to the Board the sum of $50 000, to be expended in carrying out its plans ;—and that the Institute believes that such an appropriation would be judiciously expended, and would be a real economy on the part of the United States government.

The report was accepted and the Council instructed to have a memorial properly engrossed and presented to Congress.

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From Phinehas Ball. Springfield, Mass.:

Report of the Board of Water Commissioners of Springfield. 1876.

From G. W. R. Bayley. New Orleans:

Annual Report of the Board of Health of Louisiana. 1875. New Orleans.

Comparative Chart of Mouth of South Pass, showing Location of the Jetties and Plan of Ranges for taking Soundings.

Louisiana; its Topography, Climate, material Resources, Agriculture, etc., etc., by Daniel Dennett. New Orleans, 1876.

Report and Profiles of Progress of Work at South Pass, Mississippi.

From Gen. S. V. Benet, Chief of Ordnance, War Department, Washington.

Annual Report of the Chief of Ordnance for year ending June 30th, 1875. Washington.

From C. H. M. Blake, Worcester, Mass:

Annual Report of acting City Engineer of Worcester for Year ending November 30, 1875.

Annual Reports of the Committee on Water, the City Engineer, the Water Registrar, and the Water Commissioner of Worcester, for Year ending November 30, 1875.

Engineer's Report on Sources for an additional Supply of Water for Worcester, 1875.

From A. D. Briggs. Springfield, Mass.:

Report of Hon. Alvah Crocker, Commissioner, acting as Superintendent of Work upon the Troy & Greenfield R. R. and Hoosac Tunnel, with Reports of the Chief and Consulting Engineers. Boston. 1868. (2 copies.)

Report of Joint Standing Committee of 1867 on the Hoosac Tunnel and the Troy & Greenfield R. R. (2 copies.)

Tunnel Loan Bill—an Answer to the Inquiry, why do the Contractors ask for more than the Tunnel costs? also a Reply to recent Editorials. Boston. 1859.

From J. G. Chase. Cambridge, Mass.:

Annual Report of the Cambridge Water Board, with Reports of the Registrar and Superintendent and other Documents, for 1875. Boston.

Annual Report of the City Engineer of City of Cambridge, for Year ending November 30th, 1875. Boston.

Mayor's Address and the annual Reports made to the Council, City of Cambridge. Boston. 1876.

Report of special Committee of the Water Board, in Relation to Leakage and Waste of Water. Cambridge. 1876.

From F. Collingwood, New York:

Communications to Board of Aldermen of New York, by President of N. Y. and Brooklyn Bridge, Feby. 3d, 1876. Brooklyn. (Copies for distribution.)

From Emory C. Davis. Northampton, Mass.:

Specimen Blocks of a Patent Pavement.

From Joseph P. Davis. Boston, Mass.:

Sanitary Condition of Boston. Report of a medical Commission, to investigate. Boston. 1875.

Sewerage of Boston. Report by a Commission, of E. S. Chesbrough, Moses Lane and Charles F. Folsom. Boston. 1876.

From Department of the Interior. Washington:

Bulletin of the U. S. geological and geographical Survey of the Territories. Volume II, Nos. 1 and 2. Washington. 1876.

From James B. Eads. St. Louis, Mo.:

Physics and Hydraulics of the Mississippi River. Report of U. S. Levee Commission reviewed by James B. Eads. St. Louis. 1876.

From the Editors and Publishers, New York;

The American Cyclopedia. Vol. XV. Shomer—Trollope. New York and London, 1876.

From John T. Fanning. Manchester, N. H.:

Model of Brick used in building Conduit.
Photograph of Ruins of Worcester Dam. April 1, 1876.

From James B. Francis, Lowell, Mass.:

Photographs of Progress of Dam at Lowell.

From Charles C. Gardiner. New York:

Water Meters—their Need considered. New York. 1875.

From C. O. Gleim, Cologne, Germany:

Modern American Bridge Building. C. O. Gleim. From the Journal of the Architects and Engineers' Society at Hanover. Vol. XXII. 1876. 1st part. (German.)

From D. M. Greene, Albany, N. Y.:

Annual Report of the State Engineer and Surveyor on the Canals of the State. Albany, 1875.

From D. Farrand Henry, Detroit, Mich.:

Twenty-fourth Annual Report of Board of Water Commissioners, City of Detroit, 1875. (3 copies for distribution.)

From Alexander L. Holley, New York:

Address of President A. L. Holley, before the American Institute of Mining Engineers, at opening of Washington meeting, Feb'y 22, 1876. Philadelphia. (Copies for distribution.)

From Gen. A. A. Humphreys, Chief of Engineers, U. S. A. Washington, D. C.:

Letters from the Secretary of War (2 copies each), as follows:

Communicating Information in Relation to Delays in the Passage of Tows through the Louisville, Portland Canal, and to Survey of the Mouth of the Nehalem River and of Alsea River and Bar, Oregon; and

Transmitting a report of Maj. McFarland and of Maj. W. E. Merrill, on completion of Chesapeake and Ohio Canal; and of the Chief of Engineers on the Practicability and Cost of inland Water Communication between the Mississippi River and Atlantic Ocean, etc. (2 copies.)

From William C. Potter, Supervising Architect, Washington, D. C.:

Proposals for wrought and cast iron Work for the U. S. Custom House and Post Office at St. Louis, Mo., with 20 Photographs of Drawings, illustrating same.

ANNOUNCEMENTS.

MEETINGS.—The next *stated* meeting of the Board of Direction will be held Wednesday, May 3d, at 3 o'clock P. M., for the transaction of regular business.

The next *regular* meeting of the Society, will be held Wednesday, May 3d, at 8 o'clock P. M., when ballots for members will be canvassed; discussions of the paper, "Notes and Suggestions on the Croton Water Works and Supply for the Future," by Benjamin S. Church, C. E., of New York,—will be continued; a description of "a Water Conduit under Pressure," by John T. Fanning, C. E., of Manchester, N. H., will be read; the subject of "Engineering Services, their Value and Compensation," will be considered, and of the matters taken up.

The next *stated* meeting of the Society will be held Wednesday, May 17th, at 8 o'clock P. M., when a "Note on the Resistance of Materials, as affected by Flow and by Rapidity of Distortion," by Prof. Robert H. Thurston of Hoboken, N. J., will be read, and selections from correspondence presented; after the formal session, an hour will be given to conversation.

At the *regular* meeting of the Society, June 7th, the "Theory of Continuous Girders in Relation to Economy in Bridge Building," a paper by Charles Bender, C. E., of New York, will be discussed.

THE EIGHTH ANNUAL CONVENTION of the Society will be held in Philadelphia, Tuesday, Wednesday and Thursday, June 13th, 14th and 15th next.

Sessions for the consideration of professional subjects and of regular business will be held daily from 9½ o'clock A. M. to 1½ o'clock P. M., in the Judge's Hall, on the Centennial Grounds.

A reception to the Society will be given on Tuesday evening, at the Union League Club House, by the Philadelphia members; and one on Thursday evening, by a brother member.

No excursions outside of Philadelphia will be attempted, as all the spare time at disposal of members will be fully occupied in visiting the Exposition.

The Western Gallery of the Main Exhibition Building has been fitted up, and will be used by the Society as a place for exhibits of Ame-

rican engineering, and for meeting during the Exposition.

Members can have their correspondence addressed in care of Mr. Bogart, Resident Secretary of the Centennial Commission of the Society, at the Main Exhibition Building, and will find letters and telegrams delivered at his desk.

It has not been deemed necessary to secure rooms in Philadelphia for members attending the Convention; a list of principal hotels, with prices and location, will be issued in time for members to select and engage quarters for themselves.

In accordance with the rules governing Conventions,* a list of topics to be considered, at the regular sessions is submitted, with references to the Papers treating these subjects published in the Journal since May, 1875.

I. THEORY AND CONSTRUCTION OF BRIDGES.

CXXII. The Theory of continuous Girders in Relation to Economy in Bridge Building. C. BENDER. *May.*

CXVI. The new Portage Bridge. G. S. MORISON. *January.*

CXIX. Erection of the Verrugas Bridge. L. L. BUCK. *March.*

Report of Committee on Means of averting Bridge Accidents. J. B. EADS, Chairman. *To be submitted.*

II. PRACTICAL HYDRAULICS.

CXIII. On Waves of Translation that emanate from a submerged Orifice, with an Examination of the Feasibility of the proposed Baie Verte Canal. C. HERSCHEL. *July.*

CXVIII. Description and Results of hydraulic Experiments with large Apertures, at Holyoke, Mass., in 1874. T. G. ELLIS. *February.*

Report of Committee on a uniform System of Gauging of Streams, in Connection with Observations of Rainfall. T. G. ELLIS, Chairman. *To be submitted.*

CXX. Notes and Suggestions on the Croton Water Works and Supply for the Future. B. S. CHURCH. *March.*

CXIV. Notes on the Improvement of the Mouth of the Mississippi. W. M. ROBERTS. *December.*

CXXI. Levees, as a System for Reclaiming low Lands. G. W. R. BAYLEY. *April.*

III. STRENGTH OF MATERIALS.

CXV. Note on the Resistance of Materials. R. H. THURSTON. *December.*

CXVII. The Strength and other Properties of Materials of Construction, as deduced from Strain Diagrams, automatically produced by the autographic recording testing Machine. R. H. THURSTON. *January.*

CXXIII. Note on the Resistance of Materials, as affected by Flow and by Rapidity of Distortion. R. H. THURSTON. *May.*

Report of the Committee on Tests of American Iron and Steel. W. S. SMITH, Chairman. *To be submitted.*

IV. MISCELLANEOUS. Reports of other Committees, *to be submitted:*—

On the Form, Weight, Manufacture and Life of Rails. A. WELCH, Chairman.

On Railway Signals. J. DUTTON STEELE, Chairman.

On Nomenclature and Classification of Masonry. J. J. R. CROES, Chairman.

On technical Education. H. R. WORTHINGTON, Chairman.

The following topics are set down for THE BUSINESS SESSION.

Policy of the Society. Proposed By-Law, referring to Applications for professional Service made a special order. *January* (*Proceedings, page* 2).

Conditions and Increase of Membership.

Establishment of an Engineering Library and Museum. Report of Committee. J. W. ADAMS, Chairman. *To be submitted.*

Permanent Quarters for the Society. Report of Committee. J. BOGART, Chairman. *To be submitted.*

National Recognition of the Society. Report of Committee. G. W. GREENE, Chairman. *To be submitted.*

This list is subject to change and revision as announced in the next Journal. The topics will be called for discussion in regular order, and members are invited to take part in person or by sending what they would say. It is hoped that those who have memoranda of experience or data, relating to any of the subjects named, will take care to present such.

Papers for the Convention may be announced by title, but none requiring more than ten minutes time are to be read. Members desiring to offer Papers, or to discuss on them or other topics, should give notice to the Secretary, as early as practicable.

PAPERS RECEIVED for presentation to the Society are announced as follows:—

"Strains in the braced Arch Bridge."
Discussion: Charles Bender: February 23d, 1876.

Note on the Resistance of Materials, as affected by Flow and by Rapidity of Distortion.
Robert H. Thurston. March 1st, 1876.

"The New Portage Bridge."
Discussion: Charles Macdonald. March 9th, 1876.

* Proceedings. Vol. I, page 172.

Fac-Simile Telegraphy.
Robert L. Cooke. March 27th, 1876.

A Water Conduit under Pressure.
John T. Fanning, March 30th, 1876.

"Notes and Suggestions on the Croton Water Works and Supply for the Future."
Discussion: J. B. Francis, April 4th, 1876; J. Hubert Shedd, April 4th, 1876; Wm. R. Hutton, April 6th, 1876; Galen W. Peasons, April 10th, 1876.

Determination of the Resistance of Railway Trains.
Robert H. Thurston, April 8th, 1876.

Reconstruction and Enlargement of Cook River Tunnel.
Max J. Becker, April 15th, 1876.

"American Bridge Systems": Discussion by the Paris Society of Civil Engineers. (Translation.)
William R. Hutton, April 17th, 1876.

THE ROOMS OF THE SOCIETY are open from 9 o'clock A.M. to 9 o'clock P.M., each business day, except Saturday, when they are closed at 3 o'clock P.M.

THE INDEX TO VOLUME I OF PROCEEDINGS comprising issues from November, 1873, to December, 1875, inclusive, is nearly in print. More time was required for its preparation than expected, or it would have been ready this month.

LIST OF MEMBERS.

ADDITIONS.

BILLIN, CHARLES E. [J.]	Ass't, Geological Survey of Penn. Box 2580, (Post Office), Philadelphia, Pa.	April	13,	1876.
CHITTENDEN, SAMUEL H.	Fair Haven, Conn	"	20,	"
EARLEY, JOHN E.	Res. Eng. Cin. Southern R'y, Somerset, Ky.	"	"	"
HAINES, CASPAR W. [J.]	Cheltenham, Pa.	"	"	"
M'CLINTOCK, WILLIAM H.	Ass't City Eng., Louisville, Ky.	"	15,	"
M'GEE, JOHN	Lima, Peru	"	3,	"
MOORE, ROBERT	1221 St. Ange av., St. Louis, Mo	"	15,	"
WISNER, GEORGE Y.	Ass't Eng., U. S. Lake Survey, Detroit, Mich.	"	13,	"

CHANGES AND CORRECTIONS.

BUCK, LEFFERT L. ..... Care W. W. Evans, 63 Pine st., New York.

COX, ABRAHAM B., JR. ..... Cherry Valley, N. Y.

FELTON, S. M. ..... Pres't Penn. Steel Co., 216 S. 4th st., Philadelphia, Pa.

HOWARD, FRED'K B. ..... Care Chas. H. Ellis, Abstract Building, Lafayette Av., Detroit, Mich.

MAXWELL, JAMES R. ..... Conshohocken, Pa.

PONTZEN, ERNEST. ..... Care Am. Soc. Civ. Eng., 4 East 23d st., New York.

SEDGWICK, THOMAS S. ..... 732, 21st st., N. W. Washington, D.C.

TRUESDELL, CHARLES ..... 56 Seymour st., Syracuse, N. Y.

WURTELLE, ARTHUR S. C. ..... 19 Jay st., Albany, N. Y.

American Society of Civil Engineers.

PROCEEDINGS.

Vol. II, May, 1876.

MINUTES OF MEETINGS.

(Abstract of such as may be of general interest to members.)

OF THE SOCIETY.

MAY 3D, 1876.—A regular meeting was held at 8 o'clock P. M.

The vote on admissions to membership was canvassed and the following declared elected:—Members—George S. Baxter* of New York; Charles E. Fowler of New Haven, Conn.; Robert L. Harris of Portsmouth, N. H.; Franklin A. Stratton, Coleman Sellers and William Sellers of Philadelphia, Pa.; Joseph Veazie of Boston, Mass.; and Juniors, Joseph O. Osgood and Frank O. Whitney of Boston, Mass.

At the same time, the vote ordered April 5th† to determine whether committees to examine and report on the "failure of dam at Worcester, Mass.," and on the "Resistances of Railway Trains,"‡ should be appointed, was canvassed; the vote being 150 to 9 for the former, and 155 to 4 for the latter.

During the canvass of votes, in view of the fact that the authorities of the City of Worcester had already appointed a Board of Engineers to examine into the causes of failure of the dam there, the question was considered whether the committees of the Society to be appointed should be instructed to delay presentation of its report, but no action was taken.

Mr. William J. McAlpine gave a description of the Worcester dam, and with others discussed the question, "Dams for Reservoirs, shall they be Earth or Masonry?"

Discussion of "Notes and Suggestions on the Croton Water Works and Supply for the Future"§ was continued.

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*Became Junior June 1st, 1875. †Page 49. ‡Page 48. §Transactions; CXX. Benjamin S. Church.

MAY 17TH, 1876:—At the stated meeting, Vice-President Roberts welcomed to this country, the engineers from abroad who were present; Mr. Althans responded; Dr. Raymond, and Messrs. Faber du Faur and Smith made short addresses, and the remainder of the evening was spent in conversation.

OF THE BOARD OF DIRECTION.

MAY 3D, 1876.—A stated meeting was held at 3 o'clock P. M.: proposals for admission to the Society were considered and other routine business done.

It was ordered that a general card of introduction to members of the Society be presented with a "List of Members" to foreign engineers visiting this country, who may desire it and are duly accredited.

REPORTS OF COMMITTEES.

ON TESTS OF AMERICAN IRON AND STEEL.

PRESENTED MAY 11TH, 1876.

The Chairman of Committee, appointed June 6th, 1872 and since duly continued, on Tests of American Iron and Steel, begs leave to submit the following annual report:

As the Society has been fully informed both as to the work already accomplished by the Board appointed by the United States Government, to test iron, steel and other metals, and as to the general plan adopted for its future action; the point to which the committee would now most earnestly invite attention is the effort which must be made to secure the necessary appropriation for carrying on the work.

The proceedings of the present Congress indicate a disposition to scrutinize every expenditure of the Government, and to reduce such expenditures to the smallest possible amount. To this, the Board and its friends make no objection whatever. Indeed, a thorough and impartial investigation of the value of the work done and proposed to be done by the Board, to the Government itself as a consumer of the metals to be tested, will reveal the fact that it cannot afford to be without the knowledge which the labors of the Board will surely supply.

In the columns of our Government building now in course of construction, and in the beams of another recently built, more money has been wasted than will be required to defray the expenses to be incurred in making tests for a year to come; and this waste, in a greater or less degree, is believed to run throughout the iron architecture of the country, both public and private. On the other hand, many of the metal parts of buildings, both public and private, are alarmingly weak. These opposite errors, particularly the latter, characterize the governmental and civil engineering of the country and enter in no less degree into naval construction.

Believing that the "American Society of Civil Engineers" is, and should be recognized as good authority for these and similar statements, and confident that its members, from personal observation, will endorse them; the committee once more earnestly requests the individual aid of each member in bringing the work of the United States Board to the favorable notice of Congress at the earliest possible moment.

There are some interests which the knowledge sought may injure; and there are jealousies which silently instigate opposition to the further prosecution of the work, as projected. It is certain that this opposition exists, and that the very existence of the Board is threatened.

But as engineers, we appreciate the great value of the knowledge sought, to ourselves and to the country at large; and we see clearly that Government cannot afford to persist in its mis-use of such costly materials as iron and steel in the enormous quantities in which these metals are employed in its various constructions.* And as engineers, it is our privilege and duty to bring to Congressmen of our acquaintance the knowledge which is somewhat special to our profession, and necessary to a right understanding of the merits of the work for which they are asked to appro-

* The iron and steel used in Government buildings alone during the last fifteen months amounted to over 8 000 tons.

priate money. With a hearty and immediate co-operation of all the members of the Society with the committee, with the Society in its capacity as such, and with the various other associations and institutions of learning throughout the country which are giving their aid; the committee believes that real economy will prevail over a seeming one, and that the needed appropriation will be granted notwithstanding the opposition alluded to. If is it not, our cherished work will end in something but little better than a most promising prospectus to a work to be written by a future and wiser generation.

The precise manner in which each member of our Society will render his assistance must of course be left to himself; but it is hoped that each one will, in any way which may seem best, aid in obtaining an appropriation by Congress of the $50 000 asked for by the Board appointed to test American Iron and Steel.

Respectfully submitted,

WM. SOOY SMITH, Chairman.

ON A UNIFORM METHOD OF GAUGING STREAMS.

PRESENTED MAY 30TH, 1876.

The committee to which was referred the matter of "A Uniform Method of Gauging Streams," begs leave to report:

That in the present state of the science of hydraulics, there is, in the opinion of the undersigned, no uniform method that is applicable to streams of all sizes and characters that come under the observation of the engineer. The methods of gauging must be adapted to the circumstances, according to the size and character of the stream and the degree of exactness required.

It is considered unnecessary to refer engineers to the best modern methods of measurement. The committee would, however, recommend that more importance be attached by engineers to the matter of keeping a permanent and continuous record of the heights and discharges of such streams as come under their observation, with a view to a future collection of such records for the benefit of the Society. It would also recommend that the members of the Society be requested to exert themselves to procure the establishment of permanent gauges, by the proprietors of dams, upon streams in their vicinity for the purpose of keeping a daily record of the height upon the crest of the dam; and also to obtain a plan and section of each dam for the computation of quantities flowing over them. The committee would also recommend that the engineers of cities upon the larger streams be requested to keep a record of the height of water daily, so that by means of occasional gaugings at different heights, or by means of the measured inclination of the surface, the approximate discharge could be determined. In this way a vast amount of valuable materials could be obtained which could be worked up when occasion demanded.

A very complete record of the rain-fall in different sections of the country is kept by the Smithsonian Institution, but it is believed that no effort has been made to ascertain the discharge of streams, nor keep any record of the amount of water that flows off by surface drainage.

If engineers in different parts of the country can be induced to keep a record of the quantity flowing in the streams, a great amount of information in relation to this subject might be obtained.

Respectfully submitted,

THEODORE G. ELLIS,
DAVID M. GREENE, } of Committee.

NOTES AND MEMORANDA.

METRICAL SYSTEM OF WEIGHTS AND MEASURES.

The following has been referred to the Eighth Annual Convention:

BOSTON, April 22d, 1876.

To the American Society of Civil Engineers:

The consideration of the introduction of the metric system of weights and measures in the United States has become one of the live questions of the day. A majority of the architects of the principal cities of the country have agreed among themselves, that on and after July 4th next, they would use this system in all their professional transactions. For several years, there has existed the American Metrological Society, whose principal object is the introduction in the United States of this system of weights and measures; it has the support of, and numbers among its members, many of the most eminent scientific authorities of the country, statesmen, editors, judges and others.

On or about January 20th last, the Boston Society of Civil Engineers mailed a circular to various societies throughout the country,* inviting them to petition Congress to enact, that after some date, to be fixed several years in advance, the metric standards in the office at Washington should be the sole authorized public standards of weights and measures. Up to April 20th, that is, in three months, the Committee of the Boston Society, on the Metric System, has received twenty-two replies. Twelve societies have petitioned Congress in the form recommended to them; four have declined, for various reasons; six have acknowledged receipt of the circular sent to them; some of these might be classed as having replied favorably, others are purely and simply acknowledgments of receipt only, and all are expected to give further notice of the action taken. Some societies and bodies whom the Boston Society of Civil Engineers has addressed, have taken action in this matter without sending the above named committee any notice of such action, but have been heard from through the daily papers and similar sources; the Boston Society of Arts has petitioned Congress for the appointment of a commission to report to Congress upon the subject; the Massachusetts Teachers' Convention has passed a resolve in favor of the metric system of weights and measures; the faculty of Yale College has sent a petition to Congress favoring the introduction in some form of the metric system; the "Great and general Court" of the Commonwealth of Massachusetts has passed a resolve instructing its whole delegation in Congress to forward by all legitimate means, the introduction, as the sole authorized standards in the United States, of the metric system of weights and measures.

Of our own immediate profession, the Boston Society of Civil Engineers and the Civil Engineers' Club of St. Louis, have petitioned Congress; the final action of the Civil Engineers Club of the Northwest has not been taken yet, so far as known; a report of the committee of the Club to whom the matter was referred, in favor of petitioning Congress, was published in the *Engineering News* of April 15th.

I am one of those who would like to see the American Society of Civil Engineers occupy a very high rank among the advocates of what so many believe to be a most far-reaching and beneficent reform for Congress to confer upon the nation. This is a matter touching the education of every child that shall go to school hereafter, no less than a measure of scientific and merely professional reform. Teachers and others well qualified to judge, say that it will enable one whole year of every child's school-time to be devoted to something useful were our unsystematic tables of weights and measures, the offspring of change and old-time lack of interest in the subject no less than ignorance, supplanted by a decimal system of weights and measures. I believe, that in this matter the people are looking to such as we to guide them; my earnest hope is that we may not disappoint them.

To this end, I move that the communication I made to the Society, November 2d,* be now taken from the table and placed in the order for debate and action at the Eighth Annual Convention; that a committee of five members, to be nominated by the chair, report to the Convention a form of petition to Congress, asking, that after some date to be fixed several years in advance, the metric standards in the office of weights and measures in Washington, shall be the sole authorized public standards of weights and measures; and that this Society shall petition Congress, in the form then reported and adopted.

Respectfully submitted,

CLEMENS HERSCHEL.

* Appendix to December Journal.

TESTS OF AMERICAN IRON AND STEEL.

Action has recently been taken in approval of the plans and work of the United States Board to test Iron, Steel and other metals, as follows:

CORNELL UNIVERSITY. DEPARTMENT OF CIVIL ENGINEERING:

Resolved, that the Faculty of Civil Engineering of the Cornell University considers the action of the United States Government, in the appointment of a Board for testing iron, steel and other metals, a wise and necessary measure; that it believes that the eminence of the Commissioners chosen, and the character and organization of the Board, will secure confidence in the results of the investigations of the Board, and will reflect credit upon the people of the United States.

Resolved, that since the objects of the labors of the Board are so important to the welfare of the nation, and especially to the development of engineering and metallurgical science, this Faculty desires to express the hope that the Board may be provided with ample means and granted sufficient time to complete its labors in such a manner as will make its researches available for use.

* Proceedings, Vol. I, pages 302, 321.

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

Algebra, self taught. Paget Higgs. London. *Spons.* (*New York.*) (Announcement.)

Animals and Plants under Domestication, Variations of ——. Charles Darwin. 2d ed. rev. 2 vols. New York. 12 mo, illus. *Appletons.* $4.00.

Architects, Proceedings of 9th Annual Convention of American Institute of —— held in Baltimore, November 10, 1875. New York. 4to. *Amer. Inst. of Arch.*

Architectural Iron-work; a practical Work for Iron Workers, Architects and Engineers, and all whose Trade, Profession or Business connects Them with Architectural Iron Work, showing the Organization and mechanical and financial Management of a Foundry and Shops for the Management of Iron-work for Buildings, with Specifications of Iron-work, useful Tables and valuable Suggestions for the successful Conduct of the Business. William J. Fryer, Jr. New York. 8vo, illus. *Wiley.* $3.50.

Architecture, Ornamentation of the transitional Period of British ——. M. Sharpe. Part II, No. 2. London. *Spons.* (*New York.*) (Announcement.)

—— Villas and Cottages; or, Homes for All. Plans, Elevations, and Views of 12 Villas and 10 Cottages; being a Collection of Dwellings suited to various individual Wants, and adopted to differerent Locations. William M. Woollett. New York. 8vo, illus. *Bicknell.* $3.00.

Astronomical and meteorological Observations made in 1873, at United States Naval Observatory. Washington. 4to. *Naval Obs.*

Astronomy, How to keep the Clock right by Observations of the fixed Stars. Thomas Warner. London. 8vo. *Williams & Norgate.* 6s.

Blue Ray, Influence of the —— —— of the Sun-light and of the blue Color of the Sky in developing animal and vegetable Life; in arresting Disease, and in restoring Health in acute and chronic Disorders to human and domestic Animals, as illustrated by Experiment. A. J. Pleasonton. Philadelphia. 8vo. *Claxton.* $2.00.

Botanical Handbook of common, local, English, botanical and pharmacopœial Names, arranged in alphabetical Order, of most of the crude vegetable Drugs, &c., in common Use; their Properties, Productions and Uses, in an abbreviated Form. A. C. Hobb. Boston. 8vo. *Campbell.* $3.50.

Botany, Analysis of Plants; intended for Schools and Colleges and for the independent botanical Student. Mark W. Harrington. Detroit. 4to. *Sheehan.* $0.90.

Breakwater, Manora ——. Kurrachee. William H. Price, with Abstract of Discussion. (Minutes of Proceedings, Institution of Civil Engineers). London. 8vo, illus. *Inst. Civil Eng.*

Bridges and Roofs; Treatise on the Theory of the Construction of ——. De Volson Wood. 2d ed. rev. and cor. New York. 8vo, illus. *Wileys.* $3.00.

—— Portage Viaduct on the Erie Railway. (Proceedings, Austrian Society of Engineers and Architects.) Vienna. 4to. (German.)

——; practical Notes on the Construction of Iron Highway Bridges, for the use of Engineers and Town Committees; together with a short Essay on the Application of the Principles of the Lever to a ready Analysis of the Strains upon the more customary Forms of Beams and Trusses. Alfred P. Boller. New York. 12mo, illus. *Wileys.* $2.50.

——Wooden, with special Reference to trestle ——. Ernest Pontzen. (Proceedings, Austrian Society of Engineers and Architects.) Vienna. (German.)

Bulkhead Walls: Reports of John Newton, Quincy A. Gillmore and William E. Worthen, to Commissioners of Docks, on Bulkhead Walls at Canal and King streets, North River. New York. 8vo, illus. *Dept. of Docks.*

Catalogue, Index Volume to the English —— 1856–1875. London. 8vo. *Sampson, Lowe & Co.* 42s.

Chemistry, the new ——, Josiah P. Cooke. 3d ed. (International Scientific Series.) London. 8vo. *Henry S. King & Co.* 5s.

Computations, Approximate ——. Joseph A. Skinner. New York. *Holt & Co.* (Announcement.)

Coals, the Principle of the Valuation of Gas Coals and Cannels. D. A. Graham. Oldham. 8vo. (*Van Nostrand, New York.*) $2.50.

Corporations, Treatise on the Law of manufacturing —— in State of New York, comprising manufacturing, mining, mechanical, chemical, agricultural, horticultural, medical or curative, mercantile and commercial; with the Laws regulating Business Corporations, Hotel Companies and their Organizations, Notes and Decisions governing the same, and including the Incorporation of Societies and Clubs for various Purposes, Forms of Certificates and By-Laws. John F. Baker. New York. 8vo. *Diossy.* $4.00.

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MEETINGS.—The next *stated* meeting of the Board of Direction will be held Wednesday, June 7th, at 3 o'clock P. M., for the transaction of regular business.

The next *regular* meeting of the Society, will be held Wednesday, June 7th, at 8 o'clock P. M., when ballots for members will be canvassed; selections from correspondence presented, and other matters taken up.

THE EIGHTH ANNUAL CONVENTION of the Society will be held in Philadelphia, Tuesday, Wednesday and Thursday, June 13th, 14th and 15th next.

Sessions for the consideration of professional subjects will be held on Tuesday and Thursday, from 10½ o'clock A.M. to 1½ o'clock P.M., in the Judge's Hall, on the Centennial Grounds; on Wednesday, at 8 o'clock P.M., "a regular meeting of the Society for the transaction of business" will be held in Hall of the Franklin Institute, 15 South Seventh street.

A reception to the Society will be given on Tuesday evening, at the Union League Club House, by the Philadelphia members; and one on Thursday evening, by a brother member.

No excursions outside of Philadelphia will be attempted, as all the spare time at disposal of members will be fully occupied in visiting the Exposition.

The Western Gallery of the Main Exhibition Building has been fitted up, and will be used by the Society as a place for exhibits of American engineering, and for meeting during the Exposition.

Members can have their correspondence addressed in care of John Bogart, Resident Secretary of the Centennial Commission of the Society, at the Main Exhibition Building, and will find letters and telegrams delivered at his desk.

It has not been deemed necessary to secure rooms in Philadelphia for members

attending the Convention; a list of principal hotels, with prices and location, has been sent to members that they may select and engage quarters for themselves.*

In accordance with the rules governing Conventions,† a list of topics to be considered at the regular sessions is submitted, with references to the Papers treating these subjects published in the Journal since May, 1875.

I. BRIDGES AND ROOFS.

CXXII. The Theory of continuous Girders in Relation to Economy in Bridge Building. C. BENDER. *May.*

CXVI. The new Portage Bridge. G. S. MORISON. *January.*

CXIX. Erection of the Verrugas Bridge. L. L. BUCK. *March.*

Design and Erection of the Exposition Buildings. HENRY PETTIT. *To be presented.*

Report of Committee on Means of averting Bridge Accidents. J. B. EADS, Chairman. *To be submitted.*

II. PRACTICAL HYDRAULICS.

CXIII. On Waves of Translation that emanate from a submerged Orifice, with an Examination of the Feasibility of the proposed Baie Verte Canal. C. HERSCHEL. *July.*

CXVIII. Description and Results of hydraulic Experiments with large Apertures, at Holyoke, Mass., in 1874. T. G. ELLIS. *February.*

Report of Committee on a uniform System of Gauging of Streams, in Connection with Observations of Rainfall. T. G. ELLIS, Chairman. *May.*

CXX. Notes and Suggestions on the Croton Water Works and Supply for the Future. B. S. CHURCH. *March.*

CXIV. Notes on the Improvement of the Mouth of the Mississippi. W. M. ROBERTS. *December.*

CXXI. Levees, as a System for Reclaiming low Lands. G. W. R. BAYLEY. *April.*

III. STRENGTH OF MATERIALS.

CXV. Note on the Resistance of Materials. R. H. THURSTON. *December.*

CXVII. The Strength and other Properties of Materials of Construction, as deduced from Strain Diagrams, automatically produced by the autographic recording testing Machine. R. H. THURSTON. *January.*

CXXIII. Note on the Resistance of Materials, as affected by Flow and by Rapidity of Distortion. R. H. THURSTON. *May.*

Report of the Committee on Tests of American Iron and Steel. W. S. SMITH, Chairman. *May.*

IV. MISCELLANEOUS.

Metric System of Weights and Measures. C. HERSCHEL. *December, May.*

On Railroad Accounts and Returns. W. P. SHINN. *To be presented.*

Reports of Committees, *to be called for.*

On the Form, Weight, Manufacture and Life of Rails. A. WELCH, Chairman.

On Railway Signals. J. DUTTON STEELE, Chairman.

On Nomenclature and Classification of Masonry. J. J. R. CROES, Chairman.

On Technical Education. H. R. WORTHINGTON, Chairman.

On Failure of Dam at Worcester, Mass. T. G. ELLIS, Chairman.

On Resistances of Railway Trains. W. P. SHINN, Chairman.

The following topics are set down for THE BUSINESS SESSION.

Policy of the Society. Proposed By-Law, referring to Applications for professional Service, made a special order. *January* (*Proceedings, page* 2).

Reports of Committees to be called for:

On Establishment of an Engineering Library and Museum. J. W. ADAMS, Chairman.

On Permanent Quarters for the Society. J. BOGART, Chairman.

On National Recognition of the Society. G. W. GREENE, Chairman.

The topics will be called for discussion in regular order, and members are invited to take part in person or by sending what they would say. It is hoped that those who have memoranda of experience or data, relating to any of the subjects named, will take care to present such.

Papers for the Convention may be announced by title, but none requiring more than ten minutes time are to be read. Members desiring to offer Papers, or to discuss on them or other topics, should *at once* give notice to the Secretary.

The joint meeting of the American Institute of Mining Engineers and the Society, on Technical Education, will be held at the Hall of the Franklin Institute, June 19th, at 8 P. M.

The American Institute of Mining Engineers will hold its June meeting at the Hall of the Franklin Institute, beginning Tuesday, June 20th, at 8 o'clock P. M., and to continue as will be announced at the Convention. In addition to the reading and discussion of technical papers, there will be excursions to the neighboring iron and coal regions, as follows;

*Several hotels have recently made reductions from prices quoted in the list.

† Proceedings. Vol. I, page 172.

June 22d. A trip by steamboat on the Delaware River for social intercourse and inspection of shipping facilities; the Navy Yard and prominent iron works between Richmond and Chester will be visited.

June 24th. By rail to Phœnixville and Bethlehem, Pa., visiting the copper and bridge works, the mills of the Phœnix Iron Co., and of the Bethlehem Steel Works and Bethlehem Zinc Works.

In the early part of the following week. By rail to Reading, Lebanon, and the anthracite coal fields, covering two days. The shops and mills of the Philadelphia & Reading R. R. Co. at Reading, the Cornwall iron mills, blast furnaces and the prominent features of the southern and middle coal basins will be visited.

Other excursions may be announced at the meeting of the Institute.

Members of the Society are invited to attend these meetings, to take part in the discussions, and to join in the excursions; they are requested to give early notice of an intention to do so, to Mr. ALEXANDER L. HOLLEY, President, at the rooms of the Institute, (which have been removed to) 1100 Girard street.

The Franklin Institute kindly extends free use of its Library and Reading-room to members of the Society visiting the International Exposition.

The next *stated* meeting of the Society will be held Wednesday, June 21st, at 8 o'clock P. M., when a report will be made of the proceedings and results of the Eighth Annual Convention; after the formal session, an hour will be given to conversation.

At the *regular* meeting of the Society, July 5th, the subject of "Engineering Services, their Value and Compensation," will be considered, and "Connected Segment Marine Boilers, a Demonstration of the Principles of their Construction," a paper by Charles E. Emery, C. E., of New York, will be presented.

No regular or stated meetings of the Society will be held from July 5th to September 6th.

PAPERS RECEIVED for presentation to the Society are announced as follows:—

Memoirs of American Engineering. John B. Jarvis. February 1st, 1876.

Dams for Reservoirs. Shall they be of Earth or Masonry? William J. McAlpine. April 30th, 1876.

Connected Segment Marine Boilers, a Demonstration of the Principles of their construction. Charles E. Emery. May 17th, 1876.

"Levees as a System of Reclaiming Low Lands." Discussion by G. W. R. Bayley, May, 30th, 1876.

A LIST OF MEMBERS of the Society is issued herewith as Supplement to the Journal. Members are requested to promptly inform the Secretary of corrections or changes of address.

LIST OF MEMBERS.

ADDITIONS.

FOWLER, CHARLES E.	City Surveyor, New Haven, Conn.	May 16, 1876
GLEIM, CHAS O. [C. M.]	Ast. Eng. Rheinische Eisen-Bahn, Cologne, Prussia,	" 15, "
HARRIS, ROBERT L.	Chf. Eng. C. C. R'y Ex., Portsmouth, N. H.	" 19, "
OSGOOD, JOSEPH O. [J.]	Rest. Eng. South Boston Flats, Boston, Mass.	" 15, "
SELLERS, COLEMAN	(William Sellers & Co.) Philadelphia.	" 19, "
SELLERS, WILLIAM	(William Sellers & Co.) Philadelphia.	" 15, "
VEAZIE, JOSEPH	Ast. U. S. Civil Eng., Boston Harbor, (Box 209) Boston, Mass.	" 15, "
WHITNEY, FRANK O. [J,]	Boston, Mass.	" 15, "

American Society of Civil Engineers.

PROCEEDINGS.

Vol. II, June, 1876.

MINUTES OF MEETINGS.

(Abstract of such as may be of general interest to members.)

OF THE SOCIETY.

JUNE 7TH, 1876.—A regular meeting was held at 8 o'clock P. M.

The vote on admission to membership was canvassed, and the following declared elected: Members—Joseph P. Cotton of Newport, R. I.; Edwin A. Doane of Oswego, N. Y.; James Dun of St. Louis, Mo.; William H. Newton of Chicago, Ills.; Othniel F. Nichols of Brooklyn, N.Y.; Nathan H. Whitten of Holyoke, Mass., and John A. Wilson of Philadelphia, Pa.; Juniors—Frederick Books of Boston, Mass. and Charles L. Crandal of Ithaca, N. Y., and Fellows—James G. Batterson of Hartford, Conn. and Charles R. Flint of Brooklyn, N. Y.

William J. McAlpine introduced George Kennan of New York, who had charge of an expedition sent out, some time since, to construct an overland line of telegraph to Europe by way of Behrings Straits and Northern Asia, and Mr. Kennan gave account of his operations and travels. After discussion, an hour was spent in conversation.

JUNE 13TH–16TH, 1876.—THE EIGHTH ANNUAL CONVENTION of the Society was held in Philadelphia, Pa., June 13th, 14th and 15th, followed by an excursion over the new railway line to New York and return, June 16th.

These members were in attendance: Messrs. Ernest Pontzen of Vienna, Austria; Henry Harding of Bridgeport, Samuel H. Chittenden, Theodore G. Ellis, and Charles B. Richards of Hartford, Charles E. Fowler, Albert B. Hill, and Mansfield Merriman of New Haven and Stephen C. Pierson of West Meriden, Conn.; Julius E. Hilgard, Thomas S. Sedgwick and Joseph Wood of Washington, D. C.; Robert Forsyth,

Max Hjortsberg, William H. Lotz and James D. Raynolds of Chicago, and William Sooy Smith of Maywood, Ills. ; Hezekiah Bissell of Lawrenceburgh, Ind. ; William R. Belknap, Frederick de Funiak and William H. McClintock of Louisville and Harvey R. Weeks of Somerset, Ky. ; Elmir L. Corthell of Port Eads, La. ; Mendez Cohen and Frederick H. Smith of Baltimore, Md. ; Frederick Brooks, Russell H. Curtis, S. Clarence Ellis, Clemens Herschel, Joseph O. Osgood, Edward S. Philbrick, Clinton B. Sears and Frank O. Whitney of Boston, Josiah G. Chase and Erasmus D. Leavitt, Jr. of Cambridgeport, Stephen Holman and Nathan H. Whitten of Holyoke ; Oliver E. Cushing of Lowell, William Rotch of Fall River and George A. Kimball of Somerville, Mass. ; Joseph B. Davis of Ann Arbor and Frederick B. Howard of Detroit, Mich. ; Joshua L. Gillespie of Minneapolis, Minn. ; John T. Fanning of Manchester and Robert L. Harris of Portsmouth, N. H. ; Theodore Allen and Robert Moore of St. Louis, Mo. ; Charles B. Brush, Arthur Speilmann and De Volson Wood of Hoboken, Richard D. Dodge, Charles D. Ward, John F. Ward and Lebbeus B. Ward of Jersey City, Martin Coryell and Ashbel Welch of Lambertville, William E. Kelley of New Brunswick, Horatio Allen of Orange, Samuel H. Shreve of Tom's River and Francis C. Lowthrop of Trenton, N. J. ; Charles H. Fisher, David M. Greene, John D. Van Buren, Jr. and Arthur S. C. Wurtele of Albany, William J. McAlpine of Babylon, Julius W. Adams, James H. Armington, Virgil G. Bogue, James How, Othniel F. Nichols and Ira Stanley of Brooklyn, Robert N. Brown and Oscar F. Whitford of Buffalo, Abraham B. Cox of Cherry Valley, Robert Neilson of Elmira, John G. Barnard, Arthur Beckwith, Leonard F. Beckwith, Charles Bender, Henry D. Blunden, John Bogart, Richard H. Buel, Octave Chanute, Stephen Chester, Francis Collingwood, Robert L. Cooke, J. James R. Croes, Charles E. Emery, Walton W. Evans, Matthias N. Forney, Quincy A. Gillmore, George S. Greene, Alexander L. Holley, Gabriel Leverich, Thomas J. Long, Charles Macdonald, Charles L. McAlpine, George S. Morison, James O. Morse, Edward P. North, W. Milnor Roberts, C. Ridgely Schott, Theophilus E. Sickels, Henry W. Stuckle, William H. Wiley and William E. Worthen of New York, Galen W. Pearsons of Ogdensburgh, Charles E. Fogg of Poughkeepsie, Foster Morss of Red Falls, Robert Cartwright, William A. Haven and William H. Searles of Rochester and James P. Gould of Rondout, N. Y. ; Edward N. Bebout of Canton, John H. Sargent and Charles H. Strong of Cleveland, Louis G. F. Bouscaren, William A. Gunn and Frederick C. Weir of Cincinnati and Max J. Becker of Columbus, O. ; Charles Davis of Alleghany City, Charles S. Maurice of Athens, Sutherland M. Prevost of Bedford, Calvin E. Brodhead and A. Jay Du Bois of Bethlehem, Caspar W. Haines of Cheltenham, James R. Maxwell of Conshohocken, Jacob A. Latcha of Jersey Shore, J. Foster Flagg and Charles Latimer of Meadville, Charles F. Billin, George P. Bland, John C. Bland, Robert Briggs, Alexander J. Cassatt,

Thomas C. Clarke, Edward W. Coit, John C. Da Costa, Jr., Charles G Darrach, Joseph N. Du Barry, Frederick Graff, Sidney T. Fuller, Rudolph Hering, Washington Jones, Strickland Kneass, Henry G. Morris, Henry Pettit, Franklin C. Prindle, Fairman Rogers, Coleman Sellers, William Sellers, Samuel L. Smedley, Joseph S. Smith, David M. Stauffer, Franklin A. Stratton, John P. Wilson, Joseph M. Wilson and William W. Wright of Philadelphia, Adolphus Bonzano, Amory Coffin and John Griffen of Phœnixville, Reuben Miller, William P. Shinn and Felician Slataper of Pittsburgh, J. Dutton Steele of Pottstown, James Archbald of Scranton and Arthur Beardsley of Swarthmore, Pa.; Joseph P. Cotton and George H. Norman of Newport and Charles H. Swan of Providence, R. I.; Samuel Whinery of Chattanooga, Eugene C. Lewis of Nashville and Casimir Constable of Rockwood, Tenn.; Isaac M. St. John and Henry D. Whitcomb of Richmond, Va. and Nathaniel M. Edwards of Appleton, Wis.

The several sessions of the Convention for the consideration of professional subjects were held in Judges' Hall on the Exposition Grounds, and the one for the transaction of regular business, at Hall of the Franklin Institute.

THE FIRST SESSION was called to order Tuesday, June 13th, at 10½ o'clock, A. M., by President Greene, who announced that Vice-President Ellis would make an opening address upon the "Rise and Progress of American Engineering."

THE VICE-PRESIDENT said:—At this Centennial time, when the minds of all are carried back over the past 100 years of unexampled prosperity in the United States, it may not be inappropriate to make a brief retrospect of the progress of engineering in our country since the commencement of its existence, to see what improvement has been made in the profession, and in the size and importance of its works, during the past century.

At the time of the establishment of our present government, very little had been done in the way of public improvement. A few roads had been constructed, such as were suited to the exigencies of the time, and upon them were bridges of rude construction built as occasion demanded, probably not much unlike the country roads of the present day. They were few and far between, however, and served as the only means of communication from place to place.

Very shortly after the establishment of the general government, the necessity of better means of internal communication became apparent, and considerable attention was given to a better system of roads and canals. Steam, as a means of locomotion, was then unknown. Mr. Washington, our first civil engineer, had already given much consideration to the subject of canals, particularly to the connection of Chesapeake Bay with the Ohio river, and made a reconnaissance for that improvement. He also made a report upon an examination of the Ohio river, for which he received the thanks of the Legislature of Virginia.

In 1784, he presided at a commission at Annapolis to consider a project for the improvement of the navigation of the Potomac, which ultimately became a canal to Pittsburg. He was also interested in the Dismal Swamp Canal, connecting Chesapeake Bay with Albemarle Sound. Perhaps the most important work early begun by the general government was the national road, which extended finally to Cumberland, then through the States of Maryland, Pennsylvania, Virginia, Ohio, Indiana and Illinois, to St. Louis. It was built chiefly by reserving a percentage upon the sales of government land, and was of great value to the States through which it passed, as a means of communication by wagons. A branch turnpike was also constructed from Baltimore to Wheeling. The time of transit from Washington to Wheeling, and from Baltimore to Wheeling, was reduced from eight to three days. Many other roads were projected by Congress, and built under the direction of the War Department.

These national roads were not remarkable pieces of engineering, so far as location and construction were concerned, and involved no extraordinary amount of engineering talent in building them.

Improvements in the navigation of rivers, on a small scale, were also executed by the national government, until the whole system of internal improvements came to a violent end for the time by the veto of the Maryland road project, by Gen. Jackson, after about $30 000 000 had been expended on these works.

After the war of 1812, the United States government employed Gen. Bernard, a Frenchman, with a corps of foreign engineers, upon the government roads and fortifications. Nearly if not all of the earlier fortifications of the government were designed by foreigners. They were far behind the state of the art abroad at the time, and do not reflect much credit upon the average itinerant German engineer of that period.

While the general government was looking after the roads, rivers, harbors and fortifications, the States individually were projecting canals. Pennsylvania, about the year 1788, appointed commissions to examine and report upon routes for connecting the Delaware with the lakes. They reported upon a route by the way of the Juniata, partly by canal and partly by improving the river. The result was a charter of the Schuylkill & Susquehanna Company, in 1789, and the Delaware & Schuylkill in 1790.

The New York, the Erie Canal had been projected by Governeur Morris. In Massachusetts the Middlesex Canal, from Boston to Lowell, was authorized in 1789, and finished in 1804. In South Carolina, the Santee Canal, 22 miles long, was completed in 1802.

These were but the commencement of the canal systems which were carried out afterwards by several of the States, but the canals already built showed that American engineers were equal to the task that would shortly devolve upon them.

Meanwhile a slumbering giant, that was to entirely revolutionize the system of transportation, and entirely change the direction of engineering works, was just beginning to awaken to a sense of his power, and future ascendancy over the heretofore known methods of locomotion.

In 1787, John Fitch of Connecticut built, in Philadelphia, the first condensing steam engine in America, with a cylinder of 12 inches in diameter and 3 feet stroke; and we have every reason to believe that he was at the time ignorant of Watt's experiments in England, which were not made public until 1786. This engine was placed in a steamboat, which was finished in May, 1787, and run at the rate of 4 miles per hour on the Delaware. It was moved by paddles, six on each side of the boat, moving them at one time. (Plate I.)

In 1796, the first propeller ever built was constructed by John Fitch, and experimented upon by him on the Collect Pond in New York city. (Plate II.)

On April 16th, 1798, he finished the first steamboat ever constructed to carry passengers. The cylinder was 18 inches diameter, and the speed was 8 miles per hour. The following year, 1799, this boat was run regularly on the Delaware river from Philadelphia to Burlington as a passenger conveyance.

John Fitch saw the value and importance of his invention, and has put it on record in these words: "This will be the mode of crossing the Atlantic in time, whether I shall bring it to perfection or not; steamboats will be preferred to all other conveyances, and they will be particularly useful in the navigation of the Ohio and Mississippi. The day will come when some more potent man will get fame and riches for my invention."

In 1804, Oliver Evans constructed for the Board of Health, Philadelphia, a machine for cleaning docks which he called the Orukter Amphibolos or Amphibious Digger. It consisted of a heavy flat-bottomed boat, 30 feet long and 12 feet wide, with a chain of buckets to bring up the mud, and hooks to clear away sticks, stones, or other obstacles. It also had wheels for running on the land, and a stern wheel for propulsion when afloat. It was operated by a high-pressure engine, the cylinder of which was 5 inches diameter and 19 inches stroke. The whole apparatus weighed 35 500 pounds, and could be run by the engine up any slope of less than four degrees. This seems to have been the archetype of stern-wheel steamboats, dredging-machines, and steam carriages.

Evans was not the original inventor of either the high pressure engine or the stern wheel, but he was the first to apply them to practical use for propulsion. The high pressure engine was invented by Trevithic in England, and the steam wheel was described by Jonathan Hull, also in England, in 1736. Steam was working its way onward, but at the commencement of the present century it had not yet become a motive power for transportation. Stage coaches even had not yet come into general use, and traveling was mainly done by means of the water courses and on horseback. What a field this presented to the American engineer, and how it was improved, we shall see.

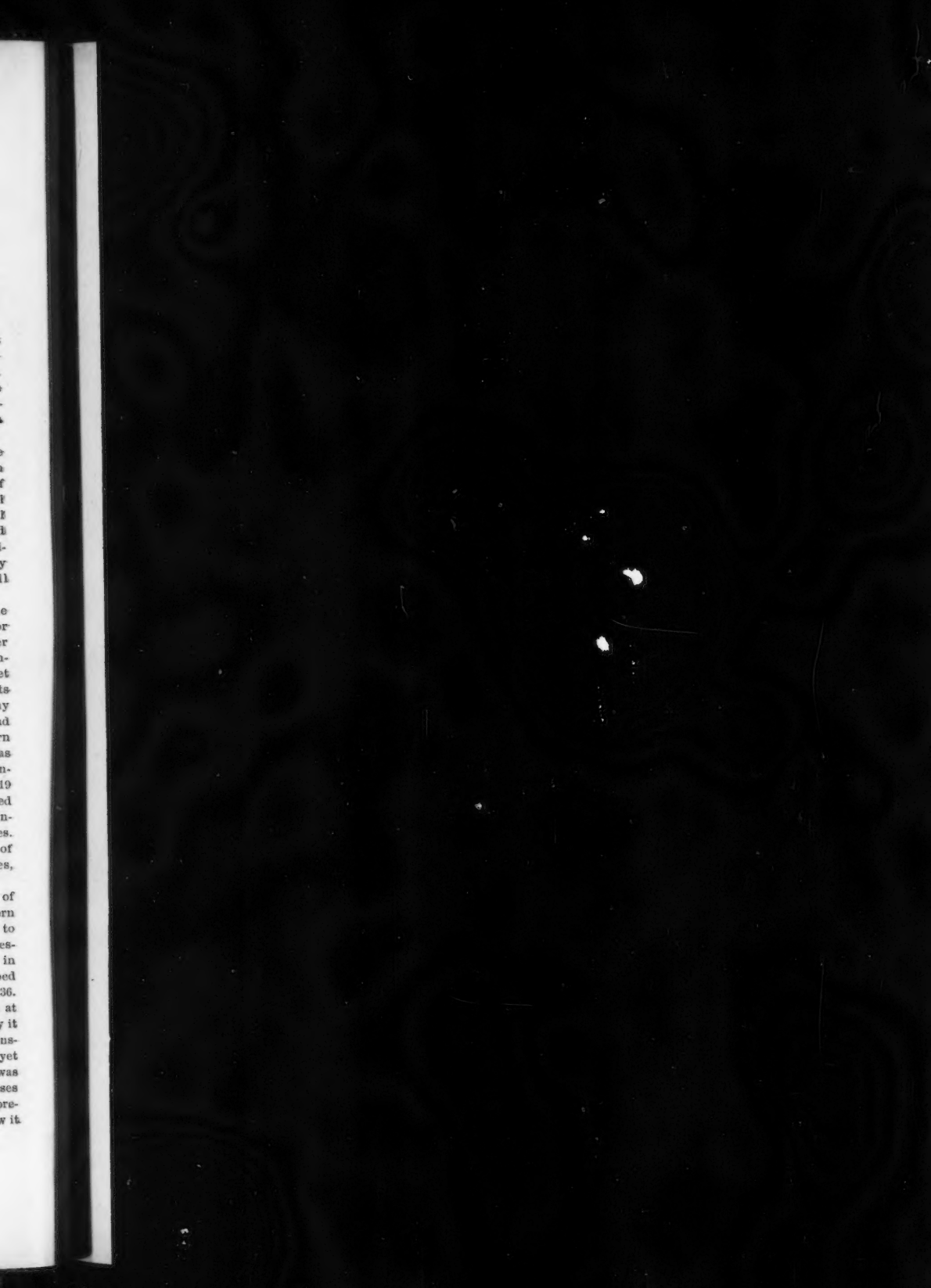
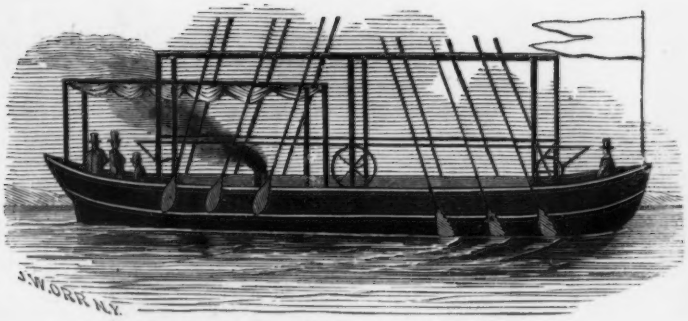
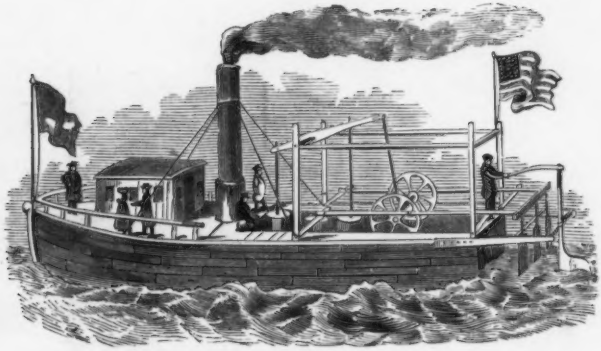


PLATE I.



THE SECOND EXPERIMENTAL BOAT OF JOHN FITCH.

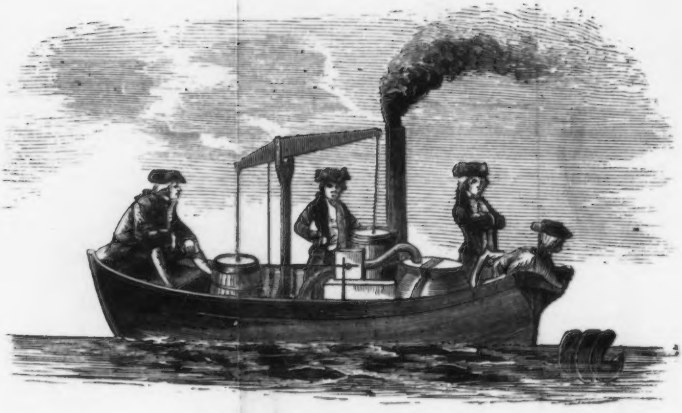
Finished in May, 1787, and run at the rate of four miles per hour on the Delaware. Cylinder twelve inches in diameter, stroke three feet.



THE FIRST STEAMBOAT EVER BUILT TO CARRY PASSENGERS.

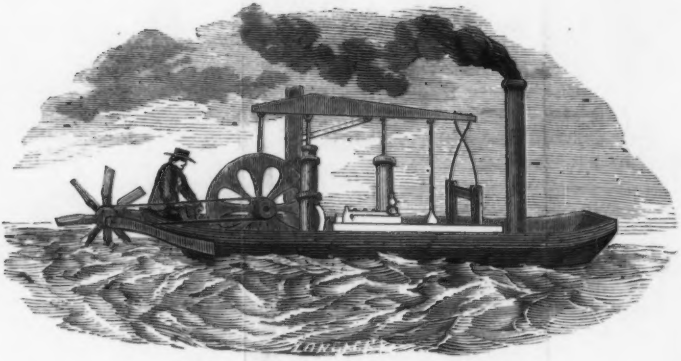
Constructed by John Fitch, and finished April 16th, 1789. Cylinder eighteen inches in diameter, speed eight miles per hour in smooth water. The following year this boat was run to Burlington regularly as a passenger boat.

PLATE II.



THE FIRST PROPELLER EVER BUILT.

Constructed by John Fitch, and experimented with by him on the Collect pond, New Y
The boiler was a twelve gallon pot, with a bit of truck-plank fastened by an iron bar placed tran
This was in the year 1796.



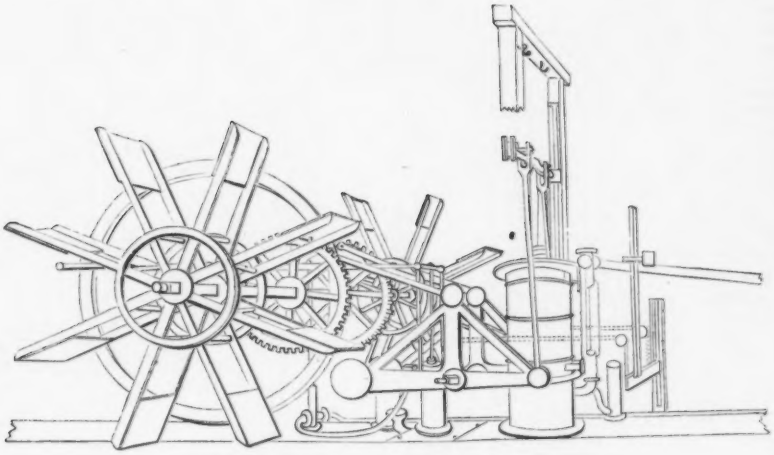
OLIVER EVANS' ORUKTER AMPHIBOLOS.

Thirty feet long and twelve broad. Cylinder five inches in diameter with a nineteen inc
Constructed by Oliver Evans about the year 1804.

pond, New York city.
ar placed transversely.

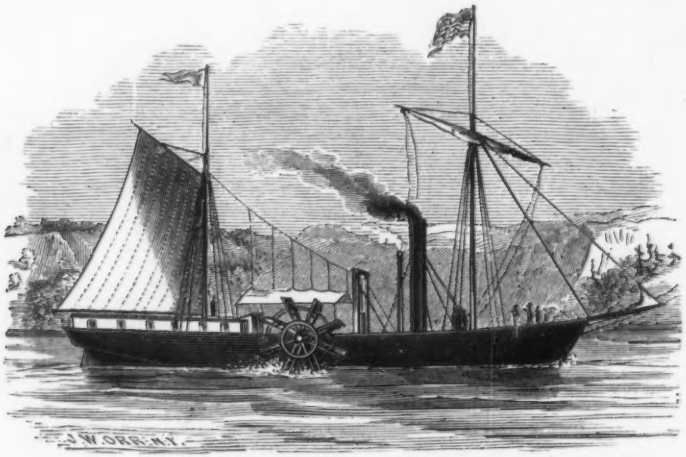
a nineteen inch stroke.

PLATE III.



THE MACHINERY OF FULTON'S FIRST STEAMBOAT.

Imported from England where it was constructed in 1805. Wheels fifteen feet in diameter, cylinder twenty-four inches in diameter, four feet stroke.



THE NORTH RIVER, OF CLERMONT.

Robert Fulton's first steamboat as she appeared after being lengthened in 1808. She was launched in 1807, and was run as a regular packet between New York and Albany. Speed four miles per hour, length 133 feet, beam 18 feet, depth 8 feet, tonnage 160.

Many are still living who might have read in a New York paper, the following advertisement: "*Sloop Experiment.—For Passengers only.*—Elias Bunker informs his friends and the public, that he has commenced running a sloop of about 110 tons burthen, between the cities of Hudson and New York, for the purpose of carrying passengers only. The owners of this vessel being desirous of rendering the passage as short, convenient and agreeable as possible, have not only taken care to furnish her with the best beds, bedding, liquors, provisions, etc, but they have been at very great expense and trouble in procuring materials, and building her on the best construction for sailing, and for the accommodation of ladies and gentlemen traveling on business or pleasure. Merchants and others residing in the northern, eastern or western counties, will find a great convenience in being able to calculate (at home) the precise time they can sail from Hudson or New York, without being under the necessity of taking their beds and bedding, and those in New York may so calculate their business as to be certain of comfortable accommodation up the river."

This was luxurious traveling for those days, but Capt. Bunker and his sloop was destined to give way to the power of steam.

In 1807, Fulton launched the "North River of Clermont," the first steamboat on the Hudson. It was 133 feet long, 18 feet beam, and 8 feet deep, and of about 160 tons burthen. She had side wheels of about 15 feet diameter, with a cylinder of 2 feet diameter and 4 feet stroke. The engine was 20 horse-power of Boulton & Watt's construction, built in England in 1805, which Fulton imported for the purpose. This boat made regular trips from New York to Albany, at a speed of 4 miles per hour. (Plate III.)

Robert Fulton, a Pennsylvanian, was a professional civil engineer; he was admitted formally in London in 1795; in 1793 he wrote a treatise upon steam navigation, of great merit at the time. In 1803, Fulton tried some unsuccessful experiments upon the Seine. In 1806, he visited the "Charlotte Dundas," a steam tow boat built by Symington in 1803, and used upon the Forth & Clyde canal, and shortly afterwards returned to New York, prepared to introduce a new era in passenger transportation.

In 1811, Fulton & Livingston built at Pittsburg the first steamboat that ever floated upon the western waters. This was the Orleans, a stern wheel boat, with two masts. In the winter of 1812, she made her first trip from Pittsburg to New Orleans in fourteen days.

In 1818, the first steamboat was built for the great lakes, at Black Rock, on the Niagara river. This steamer was named the "Walk-in-the-Water;" she was a fine vessel of 360 tons, brig rigged; with a Boulton & Watt engine, built by Robert McQueen, at the corner of Centre and Duane streets, New York city. Her cylinder was 40 inches diameter and 4 feet stroke.

Vast strides had been made in the construction of steamboats since Fulton's successful introduction of the "North River of Clermont," and they multiplied rapidly upon all our waters.

Meanwhile the character of the roads was improving, and internal land communication was becoming of more importance. The stage coach was arriving at its palmy days of transient glory, and engineers were called upon to build more extensive bridges for these rapid transit conveyances to cross the streams. Here was a branch in which American engineering early commenced to show great proficiency. The size of our rivers rendered important and substantial works necessary upon all the main thoroughfares of stage travel. The magnificent timber bridges of Wernwag over the Schuylkill and at Trenton, were constructed early in the present century, and have been a monument to the fame of the great engineer who constructed them. The celebrated bridge of 340 feet span over the Schuylkill was built in 1812, and was burned in 1838. Thus engineering progressed until the great days of railway communication opened a new field for American engineers.

It is amusing now to look back to the period just previous to the introduction of the locomotive engine, and see how the older members of the profession now living, and probably some present, traveled to their conventions, if they had any. At the commencement of the present century, conveyances between New York and Philadelphia were advertised in the Philadelphia papers, as follows:

"*Philadelphia Stage-Waggon and New York Stage-Boat performs* their *stages* twice a week. John Butler with his waggon sets out on Monday from his house, at the sign of the Death of the Fox in Strawberry Ally, and drives the same day to Trenton Ferry, where Francis Holman meets him, and proceeds on Tuesday to Brunswick, and the passengers and goods being shifted into the waggon of Isaac Fitzrandolph's the same day, when Reuben Fitzrandolph, with a boat well suited, will receive them and take them to New York that night. John Butler returning to Philadelphia on Tuesday, with the passengers and goods delivered to him by Francis

Holman, and will again set out for Trenton Ferry on Thursday; and Francis Holman will carry his passengers and goods with the same expedition as above to New York."

Somewhat later an entirely land route was adopted, as set forth in this New York advertisement. "*For Philadelphia and Baltimore—Swiftsure Mail Stage.* A new line has been removed from No. 2 Cortland to No. 116 Broadway, and is now running between New York and Philadelphia, through a beautiful country, on the short and pleasant road through Newark, Springfield, Scotch Plains, Bound Brook, Somerset, Arnwell, Coryell's Ferry, Cross Road, Crooket Billet, and Jenkintown to Philadelphia.

"To start from New York every day at 10 o'clock A. M. (Sundays excepted), lodge at Somerset, and arrive at Philadelphia the next day afternoon. The Swiftsure is the only opposition stage from this city to Philadelphia and Baltimore."

A few years more brought steam boats into competition with the mail coaches, and the number of travelers became greater, so that at that semi-centennial jubilee held in Philadelphia on July 4, 1825, it was recorded in the Philadelphia Gazette that 300 New Yorkers were said to have been in Philadelphia. There were a sufficient number of passengers to fill twenty-five coaches. Fifty years have passed on, and what would Francis Holman, John Butler and Reuben Fitzrandolph, with "his boat well suited," or thirty-five stage coaches have done with the crowd that is here to-day ?*

The advent of steam boats gave an impetus to engineering works of greater magnitude than before. On July 4th, 1817, the Erie Canal was commenced, and was finished in 1825. In 1819, the first steam-boat that ever crossed the Atlantic sailed from Savannah to Liverpool. In 1823, the Erie and Lake Champlain Canal, 63 miles long, was finished, and about this time many canals were commenced, some of which were not opened until after railroads had made considerable progress. In 1825, work was commenced on a canal, 307 miles long, to join the Ohio river at Portsmouth, Ohio, with Lake Erie. This was finished in 1833. In 1826, the canal, and afterwards partly railway route, through Pennsylvania was commenced, and this was finished in 1834, 395 miles to Pittsburgh. In 1828 the Cumberland route was commenced and finished in 1840.

* It is a remarkable fact that one of the earliest steamboat captains on the Hudson river, Mr. Cornelius Vanderbilt, is now living to witness the magnificent accomplishment of the prediction of John Fitch.

Events were progressing rapidly in American engineering about those days; canals and roads had been built, and were building and extending over the country. Steamboats had multiplied, as if by magic, upon all our lakes and rivers, and the excitement regarding internal communications was at its height, when news came across the ocean of the success of the Darlington Railway, which actually carried passengers at the astounding rate of seven miles an hour.

America was ripe for the improvement. A short railroad, the first in the country, had been opened in 1826 from Quincy to Milton, 2 miles, and the next year was continued to Neponset, 3 miles, for the transportation of stone. The celebrated Mauch Chunk Railroad in Pennsylvania was commenced, and was opened in 1827. Both of these roads were "horse railroads."

In 1828, 12 miles of the Baltimore & Ohio Railroad were completed, being the first passenger road in the country. This was two years before the celebrated Liverpool & Manchester Railway was opened, so that we see that American Engineers were not behind the times. In this same year a survey for a railroad was made in South Carolina, and the Western Railroad in Massachusetts was projected.

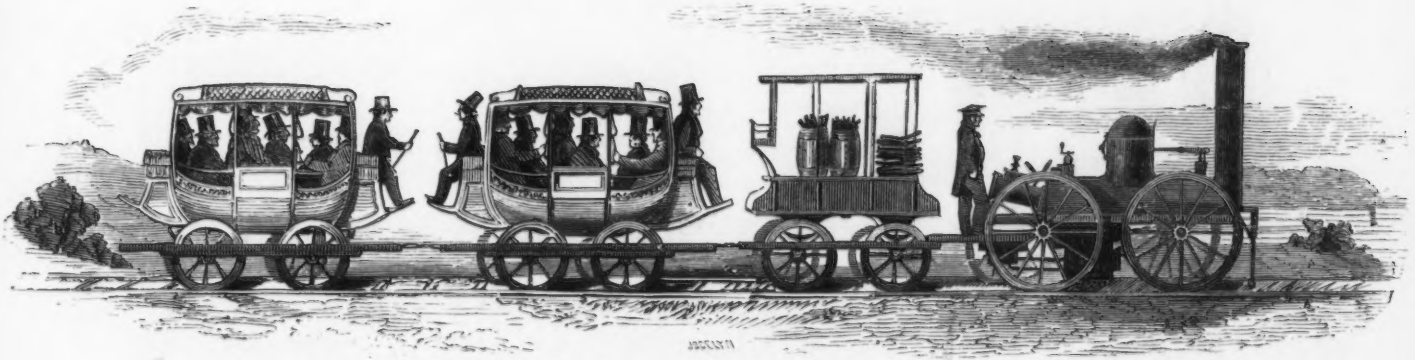
The second passenger road opened was from Albany to Schenectady on the Mohawk and Hudson. This was in 1831. The next road finished in the United States was from Richmond to Chesterfield in Va., in 1831, and the same year the road from New Orleans to Lake Pontchartrain was completed.

The reports from the Liverpool & Manchester Railroad gave a great impetus to railways in America, and they were projected in all parts of the country.

The state of the knowledge of such works at that time may be seen by the following extract from "Wood on Railroads" in 1825. "Nothing can do more harm to the adoption of railroads than the promulgation of such nonsense as that we shall see locomotive engines travelling at the rate of 12 miles an hour."

The first locomotive engine run upon a railroad in the United States was the "Lion," imported in 1829, by Horatio Allen for the Delaware & Hudson Canal Co. It was first started by Mr. Allen himself, upon the banks of the Lackawaxen, and he has graphically described it in some of his published remarks. This engine was built by Messrs. Foster, Rastrick & Co., of Stourbridge, England. Another engine built by George Stephenson, is reported to have been im-

PLATE IV.



FIRST LOCOMOTIVE EVER RUN ON THE MOHAWK VALLEY RAILROAD.

ported a short time before the "Lion," exhibited in New York, and run with its wheels raised from the ground. I do not know what road this engine was intended for.

The first engine built in this country was in the summer of 1830, for the South Carolina R. R., by the West Point Foundry Co., at their shop on West street, New York city. It was called the "Best Friend," and had four wheels and an upright boiler. This engine blew up shortly after it commenced running, and was rebuilt with a horizontal boiler. The second locomotive built in the country was the "West Point," likewise for the South Carolina railroad.

In 1831, the "De Witt Clinton" was built by the same company for the Mohawk & Hudson Railroad. This engine weighed four tons, and could run 40 miles an hour. It had cylinders 5½ inches diameter, and 16 inches stroke, with four coupled wheels 4½ feet in diameter. (Plate IV.)

Locomotives soon came into general use. Baldwin commenced building them in 1833, and Morris soon after. Then came the Lowell shops in 1835, Rogers, Ketchem & Grosvenor, of New Jersey, in 1837. Then Winans, Mason, Hinckly & Drury, and the Taunton, South Boston, Manchester, Montreal, Lawrence, East Bridgewater, and numerous other works; all of which were busily occupied in furnishing engines for our rapidly extending railroad system.

The Harris engines were the first exported, and since then, locomotives have been sent in large numbers to England, Russia, France, Germany, Egypt and South America.

The railway system opened a new field for engineering, in the substantial structures required for bridges and viaducts, which everywhere were erected, too numerous even to mention here.

Timber bridges were generally erected, and the Burr, Long, lattice, Pratt and Howe trusses, have become identified with American engineering. The Howe bridge is perhaps the most remarkable system of framing, for strength and simplicity, that was ever designed for general use in bridges of all spans.

The first iron railroad bridges were three spans, of about 55 feet each, erected on the Baltimore & Susquehanna Railroad, by James Mulholland, in 1846. These were plate girders. Iron suspension bridges had been previously used, the first in the country was erected by Mr. Finlay, over Jacob's Creek, in Pennsylvania, in 1796, and during the next 25 years about forty had been built on the same plan in different parts of the country.

A cast iron arch of 80 feet span had also been built over the Potomac Aqueduct by Maj. Delafield, in 1840.

Iron bridges, however, did not come into general use until a short time previous to the late war of the rebellion, when several roads, particularly the Pennsylvania, New York Central and New Haven, Hartford & Springfield, commenced replacing their worn-out wooden bridges with iron and stone.

The vast field opened to engineers by the building of railroads, and the incidental works, caused a great addition in numbers to the ranks of the profession, and engineering schools were opened in all sections of the country, which have graduated young men with excellent preliminary training for the profession, and have raised the standard of education for entering the practice of engineering far above what it was half a century ago. At the time of the height of the railway fever every young man who shouldered a brass instrument was an "engineer." The spirit of the times now requires that he shall know how to use it.

The railroad age culminated with the wonderful achievement of constructing a road through the uninhabited prairies and mountains to the Pacific Ocean; a great part of it at the rate of a mile a day. To a European, it is something astounding that in a country just a century old, you can start from New York and ride 3 000 miles westward by railway without changing cars; living, sleeping and eating on the train, and this chiefly through a country that half a century ago was almost wholly unexplored. Middle-aged men can remember when the Rocky Mountains were as much as "terra incognita" as the interior of Africa now is.

The railway system built up cities, and with their increase came water-works, pumping engines, systems of drainage and gas works, that in magnitude and in constructive excellence eclipse many of those of the old world. The number and magnitude of them is such as to preclude the possibility of naming them at this time. These works are so recent, that they are known to us all, and their description fills our current engineering literature. The latest works of American engineers, such as the St. Louis bridge, over the Mississippi, the East river bridge at New York, and many others of less magnitude, but equal merit; the Pacific Railroad, the Hoosac and Chicago lake tunnels, and many other recent constructions, are works of which we may well be proud, as monuments of American engineering skill. Among the more remarkable works of Ameri-

can engineering may also be mentioned the military exploits of civil engineers attached to the army during the late war; the wonderful railway bridges built in a few days at Potomac Creek and elsewhere; the release of the fleet at the Red river; the canal at "Island No. 10," and the Petersburg mine.

In the short space of a century, American engineering has risen to the highest standard, and ranks with that of any nation in the world. We have the longest railways, the best equipment and the most comfortable conveyances. We have by far the finest passenger steam boats in the world. We have the largest bridges, the greatest spans, and the deepest foundations, and the only successful railway suspension bridge in the world.

The question remaining to be solved is what are we coming to? When will our improvements end? Can it be possible that a century from this time the American engineer can look back to such a record of progress as now appears to us? I reply, it is not only possible but probable.

In the age of wood and stone implements, who could have seen the progress of the age of bronze? In the age of bronze, when the pyramids were built, and vast works of years were undertaken, who could foresee the age of iron, with its great architectural and mechanical works? And who could have foreseen the wonderful revolution upon the face of the earth that steam should produce?

At the present time I sincerely believe that the days of iron and steam are numbered. What the next great improvement will be, we cannot now know; but the signs of the times point to solar heat as the motor that will drive steam from its stronghold, and aluminum as the metal that is to replace iron. The day will soon come when men will smile at iron bridges, engines and tools. Aluminum is the most abundant and best distributed metal on the earth. Every clay bank is a mine. Ways are already known how to reduce it, but with great difficulty and expense, as silicate of alumina, clay is one of the most refractory substances we have to deal with. Let but the discovery be made, how to reduce this metal cheaper, and we might well be astounded with the changes that would occur.

With a metal only 2½ times as heavy as water, 6 times as strong as steel, as easily worked as iron, and almost indestructible in air or water, conceive what would be the possibilities of engineering skill, to say nothing of the revolution in all the tools and utensils of ordinary life. Bridges of a mile span would be entirely possible, railway trains for passengers could be reduced to at least one-fourth their weight, and the navigation of the air (all except the alighting, in which I should never have great confidence), would become practicable. With a motive power which would not be obliged to carry so great weight of fuel as our present steam engines require, speed of navigation might easily be doubled. But these are merely visions in which a practical engineer of the present day has no right to indulge; he cannot yet afford to wait for the new discoveries that are to throw our works in the shade; like the builders of the pyramids, we must go on plodding in our old-fashioned way, leaving to those of our profession who shall look back upon us from the stand point of the next century, to say if any of us shall be ranked among the "old masters."

On motion, Mr. Thomas C. Clarke was declared Chairman of all but the business session of the Convention; on taking his seat, he briefly thanked the members present for the honor conferred, and welcomed them to Philadelphia.

The order of business was presented as previously announced*:—the day sessions to be devoted to the consideration of professional subjects and the evening session to the transaction of regular business as set forth in the published list of topics—each topic to be called for discussion in regular order.

The consideration of professional subjects was entered upon, and the first topic "Bridges and Roofs" called; under it, the "Theory of Continuous Girders" was discussed by Messrs. Herschel, Du Bois and Bender, and an account of the "Design and Erection of the Exposition Buildings" was given by Mr. Pettit and discussed by Mr. Schwartzman.

* Page 69.

Announcement was made of a reception to the Society and invited guests that evening, by members resident in Philadelphia, at the Union League Club, and on Thursday evening, by Prof. Fairman Rogers at his house. An offer from the American Dredging Co. by Mr. Prindle, Secretary, of an excursion on Delaware river, with opportunity to inspect important works, was accepted for Wednesday P. M., with thanks.

The Chairman called attention to the joint meeting of the American Institute of Mining Engineers and the Society, on "Technical Education," to be held in the Hall of the Franklin Institute, Monday evening, June 20th, and invited members and others interested, to attend and take part.

Mr. Bogart referred to the exhibit of the Austrian Society of Engineers and Architects in the Main Building, and in its behalf laid before the Convention a formal presentation, (per Mr. E. Pontzen, Chairman of Special Committee for the Centennial) Exhibition to this association, as an expression of international friendship and good will, of such, to be delivered at the close of the Exposition.

The text of the paper was as follows:

The Austrian Society of Engineers and Architects, in Vienna, having arranged in connection with the Universal exhibition of Philadelphia, 1876, a special exposition of drawings, plans and photographs, representing inventions, works or buildings projected or executed by members of this Society, would feel honored by the American Society of Civil Engineers in New York, accepting the exhibited objects named in the enclosure, which the Society begs to offer as a sign of professional consideration and international friendship. The Society gladly profits by this opportunity to present to its American colleagues its best wishes and congratulations on the great centennial festival of the United States of America.

On motion, the gift was accepted, and the President and Secretary were appointed a committee to properly express to the donors the thanks of the Society.

Messrs. Shinn and Bogart referred to interesting exhibits of engineering subjects; request was made that attending members, who had not already registered their names, should do so, and the Convention adjourned to meet in business session, Wednesday evening, at 8 o'clock.

THE SECOND SESSION was called to order at Hall of the Franklin Institute, Wednesday evening, at 8 o'clock, for the transaction of regular business, President Greene in the chair.

The amendment to the By-Laws, recommended December 1st by the Board of Direction to the Society for adoption,* and the substitutes proposed January 5th,† consideration of which was made a special order at this session, were taken up.

The amendment is:—

"Section.... Upon application to the Society for professional service, the President and Board of Direction shall in each case take such action as they may deem best. If they appoint members for the service, the President shall make the nominations, subject to revision and addition by the Board."

The substitutes are:—

"1st. Upon application to the Society for professional service, the President shall in such case recommend members therefor, subject to revision and addition by the Board of Direction;"—and

"2d. Application to the Society for professional service shall be referred to the President and Board of Direction, for suitable action.

* Vol. I, page 328. † Page 2.

Mr. W. J. McAlpine moved to lay the proposed amendment and its substitutes on the table.

MR. BOGART said :—This Society has largely increased in numbers, and any change in its laws, liable to provoke criticism or produce harm, should be well considered at a meeting like this, when many of the members are present.

The matter submitted is a delicate one; various expedients covering the case have been proposed, but, in my judgment, all are unsatisfactory. I do not see why this By-Law should be adopted, and believe it would do the Society harm.

Mr. Herschel offered the following, as an amendment to the motion :—

Resolved, that this Society cannot undertake to discriminate as to the relative merits of its members among themselves, and that all applications to the Society for professional services, or for the names of members to perform such, be referred to the President and the Board of Direction, to be answered by them, by sending to the applicant a list of all the members of the Society, together with a copy of this resolution.

MR. T. ALLEN said :—I think, considering the amount of engineering now done, the advance in the various branches of practice and the extensive field which is covered, engineers must more and more take up and pursue, special subjects.

It is important this Society should stand permanently before the public at large, and it seems to me proper that it should be referred to, when experts to perform a particular work are required. A classified list of members, who devote themselves to particular branches of the profession could be prepared, and furnished to applicants to make selections from.

MR. WOOD said :—It will be a delicate matter for the officers of this Society to name experts or to attempt to classify them. A party desiring to employ an engineer for a certain work, and in doubt whom to select, can always make inquiry and obtain sufficient information upon which to found a satisfactory opinion regarding professional merit. This is the old way; the one proposed is so full of embarrassments, that were it adopted, I would request not to be mentioned under it.

MR. CROES said :—This question has come up several times in New York, and been freely discussed. I favor voting upon it by letter ballot, which would effectively decide it.

THE SECRETARY said :—I will state upon what occasions, officers of the Society have been formally requested to designate members for professional service.

The Secretary of War asked the President of the Society, *first*—to nominate one of the Government commission to examine and report upon the improvement of the Mississippi mouths, which was done and the member appointed, and *second*—to name several members from whom the President of the United States might select three civil experts to serve on the Government commission to test iron, steel and other metals; ten members were nominated by the Board of Direction, and from these the appointments were made. *Third.*—The Engineer in Chief of a public department in New York, in a communication submitted to the last Annual Convention* suggested the appointment of a committee to examine the plans in use in that department with a view to determine certain questions of practice. The communication was ordered on file; subsequently, a commission of three (two of whom were Members of the Society), was appointed by the city authorities, to report on them and similar questions. *Fourth.*—The Mayor of Providence asked the Society to appoint a committee to examine and report upon the sewerage system of that city†. The Board of Direction named several experts, and from these the committee was afterwards selected.

This statement indicates the difficulty in complying with these and similar requests of public officials. I presume the chief object of the By-Law submitted, is to relieve officers of the Society from a grave responsibility.

Mr. McAlpine's motion was then voted on and not adopted. Mr. Herschel's amendment was taken up. Messrs. Allen and Croes each offered a substitute; the first was :—

Resolved, that the President and Secretary of the Society be directed

* Vol. 1, page 263. † Vol. 1 pages 199, 300.

to request members willing to act as experts, to say in what branches of engineering they are willing so to act, and when the Society is called upon to name members to perform professional duties, there should be sent to the applicant a list of those who have thus expressed their willingness to act as experts in the particular branch or branches to which the application refers. The second was :—

Resolved, that it is not advisable for this Society, to nominate or appoint special committees or bodies of experts, at the request of individuals or corporations.

Mr. Croes moved that these three resolutions be submitted to the Society, to be voted upon by letter ballot.

MR. FISHER said :—The rules now proposed would in effect, be more damaging than to name experts as heretofore. No complaint is made against the latter method, and I see no good reason for a change. The President can always name a sufficient number of engineers skilled in a particular branch of practice, from which the applicant may select.

THE PRESIDENT said :—It will be an unpleasant duty to point out among members those possessing special features or qualification for a particular work, and if it can be avoided, this duty should not be imposed upon the Society or its officers.

MR. SEDGWICK said:—If the nomination of persons to perform special engineering service cannot be done by the officers of the Society, who are intrusted with its management, and charged with its welfare, who can do it? Reference to a list of members, in most cases, will not aid an applicant in m king selections; if this matter cannot be left with the Society's officers, I think it should not be touched at all.

MR. ALLEN said:—The object of my amendment is to relieve the Board of Direction from this burden of selection. When a list of them is given to an applicant of those members who are able and willing to examine a particular subject, the Board has done all it can or ought to do, the Society will be benefited and the public secured.

The Society is large and increasing; I think it should be willing to supply this and similar means of reliable information. If members wishing to perform expert service, would so inform the officers of the Society, the list could be prepared and issued as proposed, thus relieving the officers of the Society from much responsibility.

MR. BOGART said:—It is suggested that generally the men who offer themselves, will not be wanted for this service, as reference to the examples quoted by the Secretary shows. The demand sought to be answered by the By-Law and resolutions, is for men of conspicuous skill and knowledge in their chosen branch of practice, and whose opinions will be accepted without question.

MR. HERSCHEL said:—There are two classes of engineers, one does honor to our Society, the other has come into the association as if it were a grand intelligence office, and should not be encouraged. Applications for professional service, as were referred to, from the Federal Government will be rare. I am aware that the officers of the Society are reluctant to answer such; if it must be done, why not let the Society do it?

MR. W. S. SMITH said:—The officers of this Society were asked to name experts on the Government commission to test iron, steel and other metals, by direction of the President of the United States, who knew that the work of the commission was to be performed largely through the agency of this association, and naturally desired it to select those to whom the work should be entrusted. Such requests, however, will be rare.

I doubt whether many members are willing that this Society should employ them, or in any way determine their engagements. I am not altogether opposed to nominations of experts, upon some definite plan, by the Society. In my judgment, such appointments in the interest of the Society or of the public generally, may be made with propriety. I however decidedly object to the idea of classification as proposed, or any similar interference with individual action.

Mr. Emery moved to amend Mr. Allen's substitute by inserting after "experts," instead of what therein follows :—

— to furnish a statement of the work they have done and papers published, relating to particular engineering subjects, and when application

is made to the officers of the Society for name and address of parties qualified in any particular branch, such of the statements furnished as are applicable shall be forwarded to the applicant without any recommendation whatever.

Reference was made to the By-Laws (last section), defining how they may be added to or amended, and the question raised whether the By-Law and substitutes, regularly proposed and made the order of business at this session, had not precedence.

Mr. Allen withdrew his substitute, that the main subject could be considered. Mr. Herschel moved—that action on the By-Law be printed and referred to the Annual Convention, and in the meantime the Chair shall appoint a committee of five, who shall post a By-Law, at least thirty days before the next Annual Convention, so that action thereon may be taken.

The Chair decided, that the motion was not in order, that Mr. Herschel's amendment could not then be considered in place of the proposed By-Law, and that the question before the Convention was, the adoption of this By-Law or one of its substitutes, as previously submitted and made the order of business. This decision was appealed from, and upon vote the chair was sustained.

Separate votes were taken upon the substitutes and proposed By-Law, and neither was adopted.

Mr. Herschel offered the following :—

Resolved, that in the opinion of this Convention, it is inexpedient for the officers of the Society to take action upon applications for members to perform professional services.

Mr. Allen moved to substitute therefor, the resolution he previously offered—which was not agreed to. Mr. Herschel's resolution was then adopted.

Invitations to members and their friends were received and accepted with thanks—from managers of the "New York & Philadelphia New Line" for an excursion on Friday, June 16th, to New York and return, and from the Franklin Institute, to visit during the Exposition its Reception Room at the northwestern end of Machinery Hall.

It was stated for Committees on "Establishment of an Engineering Library and Museum," and on "Means of Averting Bridge Accidents," that no action had been taken since reports were made to the last Annual Convention. Mr. Bogart, as Chairman of Committee on "Change of the Society's Rooms,"* and Mr. Roberts, for Committee on "National Reorganization of the Society,"† each presented a report which was accepted and referred to the Board of Direction, with power to act. These committees were then discharged.

Mr. Bogart referred to the clause in Article XX of the Constitution providing that "in elections for membership of either class * * three or more ballots cast in the negative shall exclude," and submitted for consideration, whether this number should not be increased.

* Page 87. † Page 87.

MR. BOGART also said:—It is understood that at these Annual Conventions, questions important to the welfare of the Society are to be brought forward and discussed freely. The clauses in the Constitution referred to, was adopted when there were about 50 voting members, now there are nearly ten times as many and by it, persons are kept out of the Society who should belong to it. An expression of the views of those present, is desired.

Mr. Emery moved—that the number of votes required to reject an applicant be three per cent. of the voting membership. This substitute was offered:—

Resolved, that the Constitution be amended, so as to require a negative vote of two per cent. of the regular membership to reject an applicant.

MR. COLLINGWOOD said:—The examination of an applicant's professional record is searching and thorough—but is there enough attention given to his social and personal record? This in many respects, is equally important.

MR. MORISON said:—It seems to me that the votes necessary to reject a candidate should refer to a certain percentage of the whole voting membership, or a certain other percentage of the members voting—say ten of the former or three of the latter.

Perhaps the change may be better made, in another direction. If three members can exclude, at least five should propose, and in so doing, fully recommend and endorse the candidate.

MR. WOOD said:—It is a difficult thing to determine what should be done in this regard. A percentage seems to be unnecessary; any definite number of adverse votes fixed upon will be generally sufficient. Our strength does not lie so much in this, as in the care taken by members, in proposing a candidate that he be a fit and proper person for admission.

MR. COHEN said:—The Board of Direction has canvassed the matter very well, I think, in each case. The difficulty, I presume, is to know of an applicant all that is required to pass an impartial judgment upon his standing and merits, and this may generally be overcome by inquiry. What the number of adverse votes to reject a candidate should be, does not seem to me very important; whether six, eight, ten votes, or two per cent. of the voting members.

MR. SEARS said:—I would suggest that this number be not greater than that of members of the Board of Direction. One may be proposed whose reputation, outside of his profession, is objectionable. We should not only look to the professional ability of a man but his character in every respect. To be sure, this is vouched for to some extent by the proposers; but such endorsement is often a matter of friendship, or imperfect from lack of knowledge of the applicant.

MR. FISHER said:—Most of the members of the Society are not known to a considerable number of other members, and still we may be asked to propose an acquaintance under circumstances which render it difficult to refuse, though we know but little of his qualifications.

MR. MACDONALD said:—I hope the motion will not prevail. The Society is new, its membership extends over the whole country and a candidate may not be known by enough members to be judged rightly when his application is acted on, if the number of adverse votes required is increased. So long as there is no provision in the Society's laws to get rid of an objectionable member, the proposed change will tend to open wide the way to admission.

The matter was laid upon the table, and the session adjourned to be continued for the transaction of regular business, if necessary, on Thursday June 15th, at an hour to be fixed by the Convention.

THE THIRD SESSION was called to order, Thursday, June 15th, at 10½ o'clock, A. M., Mr. Clarke in the chair.

The consideration of professional subjects was resumed: the first topic "Bridges and Roofs" was taken up; under it, papers on the "New Portage Bridge," by Mr. Macdonald, and "Erection of the Verrugas Bridge," by Mr. Bogue were read, and the former discussed by Mr. Morison.

The second topic, "Practical Hydraulics" was called: under it, "Waves of Translation, that emanate from a submerged Orifice," was discussed by Messrs. T. G. Ellis and W. J. McAlpine; "Results of hydraulic Experiments with large Apertures" by Messrs. Herschel and T. G. Ellis; the Report of Committee on a "Uniform Gauging of Streams in Connection with Observations of Rainfall,"* by Messrs. T. G. Ellis and D. M. Greene of Committee, was read, accepted, and then discussed by Messrs. Croes, D. M. Greene and T. G. Ellis; "Notes and Suggestions on the Croton Water Works and Supply for the Future" were discussed by Messrs. W. J. McAlpine and Croes; a paper on "The Improvement of the Mouth of the Mississippi," by Mr. C. W. Howell, was read, and the subject discussed by Messrs. Corthell, W. J. McAlpine, W. S. Smith, Macdonald, Flagg, Herschel, Graff, Roberts and Barnard.

The Convention took a recess for one hour and was again called to order at 2½ o'clock P. M.

Invitations were presented and accepted with thanks;—from Mr. H. R. Worthington to inspect the Duplex Pumping Engine which supplies the Exhibition Grounds; from Mr. Roy Stone, to examine his Elevated Single Rail Railway across the Landsdown Ravine, and Mr. Louis Merrill to visit his torpedo boat lying in Delaware river.

Reference was made to interesting exhibits of engineering subjects, and the regular order of business was resumed.

Under the third topic, "Strength of Materials," the Report of Committee on "Tests of American Iron and Steel,"† by Mr. W. S. Smith, Chairman, was read, accepted and then discussed by Messrs. W. S. Smith and Chester.

Mr. Smith said:—I cannot do better in presenting this matter for your earnest consideration than to read the report of the committee charged with the duty of soliciting the aid of our Government necessary to make the tests of American metals, recently submitted to the Society, and printed for your information. It was prepared pursuant to notice by the Secretary that it would be required at this time, and is simply my report as Chairman.

I feel that I owe it to the other members of the committee to say, that then there was not sufficient time remaining, to confer with them nor to submit this report for their consideration and action.

(The report was read, after which Mr. Smith continued):

This matter has been thoroughly presented to Congress and pressed upon the attention of the Committee on Appropriations.

It is however thought that at present, but a re-appropriation of the unexpended balance now in the hands of the Board can be procured.

No member of the Board except its Secretary receives any compensation for his services in making these tests, and he but $1 200 per year. Four members of the Board are already salaried officers of the Government, and the two others give their services gratis. The balance on hand, about $19 000, will be sufficient, it is hoped, to carry the work along until a better temper prevails in Congress, when really deserving works of vital interest to our country will receive the support they merit. But if the members of this Society will not exert themselves to convince members of Congress that the appropriation is one which it is eminently right that they should make, all the efforts already put forth may prove unavailing.

The argument that will be used against us, no doubt, and one that at first appears quite strong, is—the Government in its embarrassed condition must stop expending money and making the numerous appropriations called for. But every member of this Society, and every member of Congress, too, who comprehends the situation, recognizes the fact that

* Page 61. † Page 60.

sound economy dictates the expenditure of the small amount of money required to make these tests, which promise a saving to our Government and people of hundreds of thousands of dollars.

A knowledge of the right use of these valuable materials will increase their consumption, stimulate efforts to improve their qualities, foster the interests of those engaged in their production and employment, and quicken the pace at which we, as a people, are moving toward the leading position among the metal producing nations of the world.

We must bring this matter before Congress in this light, and do our whole duty, and if its members err, let them do so with their eyes wide open. I do not despair, we have many good friends in Congress, and I think the appropriation will be made. President Grant has been our friend from the beginning and has kindly sent a special message to Congress in our behalf, submitting for its consideration, the various resolutions and memorials passed by learned societies and institutions of learning throughout the land.

I think, with the aid of the Society, in getting the matter fairly before the House, the necessary appropriation will be made and the work will go on, and to this good end, let me once more earnestly ask each member of the Society to exert his influence now in favor of the appropriation,

The Chairman of the Committee was requested to prepare an appeal to members of Congress,* the same with this report, to be promptly sent to each member of the Society.

Under the last topic; the "Metric System of Weights and Measures" was presented by Mr. Herschel, who offered the following:—

Resolved, that the American Society of Civil Engineers will further, by all legitimate means, the adoption of the metric standards in the Office of Weights and Measures at Washington, as the sole authorized standard of weights and measures in the United States; that the Chair appoint a committee of five, to report to the Society a form of memorial to Congress, in furtherance of the object expressed; and that the foregoing be submitted to the Society and voted on by letter ballot.

This was discussed by Messrs. J. B. Davis, C. Sellers, Herschel, Hilgard, D. Wood, T. G. Ellis and R. Briggs, and the matter was referred to a committee of five to be appointed by the Chair, and report at the next Annual Meeting.

Mr. Shinn read a paper on "Railroad Accounts and Returns†" which was discussed by Messrs. Fisher, Latimer, Shinn, Cohen and Roberts, and the following was offered:—

Resolved, that a committee of five be appointed by the Chair, to consider the subjects of uniform accounts and returns of railroad companies.

The Chair referred to the By-Law‡ relating to the appointment of special committees on engineering subjects, and under it the question of appointing committees on the "Metric System of Weights and Measures," and on a "Uniform System of Railroad Accounts and Returns," was referred to the Board of Direction.

Mr. Fisher, for Committee on "Railway Signals," stated that no action had been taken since the last Convention; Mr. Welch, Chairman of Committee on "Form, Weight, Life and Manufacture of Rails," and Mr. T. G. Ellis, Chairman of Committee on the "Failure of Dam at Worcester, Mass.," presented reports which were accepted: the latter

* Page 89. † CXXIV. Transactions, Vol. V, page 215. ‡ Page 2.

was discussed by Messrs. W. J. McAlpine and Ellis, and these committees were discharged. Mr. Croes, Chairman of Committee on "Nomenclature and Classification of Masonry," and Mr. Shinn, Chairman of Committee on "Resistances of Railway Trains," presented reports, which were accepted: the latter was discussed by Messrs. Fisher, Shinn and J. B. Davis, and the committees continued. An informal report from Committee on "Technical Education" was presented, and attention again called to the meeting, with the American Institute of Mining Engineers, to be held as previously announced.

The Centennial Commission of the Society presented a statement.

The Centennial Commission of the Society calls attention to the interesting collection of exhibits, illustrating both the past and present of engineering in America.

From the fact, that this collection has been constantly increasing, since the opening of the Exhibition, and that even now many articles are to be added, the expense of the work connected with it, has been considerable.

The original estimate of the total expense was $5 000, and the subscriptions amount to about $3 500. The Commission desires it to be understood, that, at least, this balance, $1 500, will be required to defray current expenses, and after the close of the Exhibition the goods are to be properly packed and returned.

Of course, good use can be made of additional funds, in preparing and printing papers which have and can be secured, referring to this centennial exhibit. It is also to be remembered that the library and collections of the Society will be greatly enlarged through the agency of this Commission.

There were presented to the Convention and declared a part of its proceedings: papers on—"Gauging of Streams, a special Case," by D. M. Greene; "Cut Offs on the Mississippi, their Effects on the Channel, above and below," by C. G. Forshey, and "Qualities of Iron and Steel," by W. Metcalf; and discussions on—"Notes and Suggestions on the Croton Works and Supply for the Future," by J. P. Davis; "Levees as a System of reclaiming Low Lands," by G. K. Warren, by C. G. Forshey and by G. W. R. Bayley; "The Metric System of Weights and Measures," by T. G. Ellis, and "Railroad Accounts and Returns," by A. D. Briggs and by Albert Fink,

On motion of Vice-President Roberts, the sincere thanks of the Convention and Society were tendered to members resident in Philadelphia, for their entertainments and attention; to others, individuals and corporations, who extended courtesies to attending members; to the officers of the Centennial Commission for the use of "Judges' Hall," and to the Chairman for the courteous and impartial manner in which he presided.

The Chair made brief acknowledgment. Whatever business of the Convention, not of a professional character, remaining unfinished was referred to the next regular meeting of the Society, and the Convention adjourned.

OF THE BOARD OF DIRECTION.

JUNE 7TH, 1876.—A stated meeting was held at 3 o'clock, P. M.: proposals for admission to the Society were considered and other routine business done.

REPORT OF COMMITTEES.

On Change of the Society's Rooms.

Presented June 14th, 1876.*

The Committee on Change of the Society Rooms (permanent quarters for the Society), begs to report:—

The lease under which the present rooms are held, continues in force until May next. The experience of the past year seems to show that the present location is more convenient to a larger number than one much further down town, and also that the increased facilities at these rooms for evening meetings are appreciated by members.

Not much success has resulted from negotiations for mutual action with other societies, but the Committee recommends that these be continued so far as to ascertain whether any advantage either in accommodation or expense may be thereby secured.

The Committee also recommends that steps be taken in time either to negotiate for a favorable lease for an additional term of the present rooms or for a lease of other rooms in the same general locality, and that authority be given for such action.

Respectfully submitted.

John Bogart, W. Milnor Roberts,
Chas. Macdonald, Francis Collingwood,
Of Committee.

* Report was accepted, referred to the Board of Direction, with power to act, and the Committee discharged.

On Securing a National Recognition of the Society.

Presented June 14th, 1876. *

The Committee to which was referred the subject of "Securing a National Recognition of the Society by Federal Charter or otherwise," respectfully offers the following report:—

After due consideration, the opinion of the Committee is that the primary advisable plan of securing a national recognition of the Society, is through a federal charter. If this can be obtained, it will not only secure the recognition of the Society by the government; but it will change the comparatively local status, arising from its present corporate existence under the laws of a single State. Our members reside in various States, scattered over the union, and some of them belong to other countries; so that the membership is already quite national, as well as to some extent cosmopolitan.

Within the last few years, the Society has increased its membership much more rapidly than formerly, until it now numbers in all over 500 members, who combine a vast amount of varied experience in every branch, not only in civil engineering proper, but in many of the allied branches of scientific and mechanical engineering.

For a number of years, the Society was in a comatose state, and nothing was done beyond keeping up the organization, without meetings or work of any kind; but during the last ten years efforts have been made to imbue it with fresh life and energy, through more frequent meetings and publications of numerous papers contributed by its members; and also by encouraging the admission of new members. These efforts have been attended with great success, and the Society is now a live, working organization, in good standing at home and abroad, and giving promise of annually augmenting its influence and worth.

The Society has advanced rapidly in public estimation; and, by its conservative course, it has, we think, deserved the general favor which is now extended to it.

Its latest forward movement, in the appointment of a Centennial Commission, composed of its own members, for the purpose of exhibiting in the International Exposition in Philadelphia, the progress and practice of American engineering, will, it is believed, be the means of inaugurating a very interesting feature, which promises to benefit not only members of the Society and others in our country, but many of the visitors from other lands, and from other societies. The fact that the funds for this purpose have been raised by voluntary subscriptions among its members and other gentlemen and other organizations friendly to the undertaking, without drawing from the funds of the Society, shows that there is a commendable spirit of liberality and enterprise among its members, entitling the Society to most favorable consideration.

* Report was accepted, referred to the Board of Direction, with power to act, and the Committee discharged.

Although the leading object of the Society is the mutual improvement of its members professionally, this professional improvement naturally and inevitably ramifies and sends its influence through all the parts of our vast country, and even extends beyond its boundaries into other regions, wherever public improvements may be in progress.

Its chief design is to elevate the tone, and enlarge the sphere of operations of the American civil engineer, and thus to render him capable of fulfilling his very responsible duties, not only with more credit to himself, but with more profit and greater safety to the public, in whose behalf the bulk of engineering works are planned and constructed.

Therefore, to some extent, the strengthening of the hands of this Society is a practical insurance, as it were, upon the public improvements of the country; whether they consist of canals, reservoirs, harbors, rivers, railroads or bridges, &c., or of ships, forts and armaments; and it is a mutual insurance, which tends to the protection and benefit of all classes. It should be, and we trust it will be, the pride of our country, not only to favorably recognize the American Society of Civil Engineers, but to extend toward it a liberal and enlightened recognition; such as will command the respect of all civilized governments. There is already a gratifying mutuality of feeling between this Society and other analogous associations in Europe, and in the United States; and this friendly feeling will probably be greatly strengthened during the continuance of the World's Exposition. In fact, the whole scheme of the Centennial—the planning and construction of the various buildings; their arrangements; their adoption to the different specialties, and the endless variety of the things to be exhibited, will be eminently interesting to civil engineers from all parts of the world.

The United States government, representing the whole American people, may not only properly take notice of this Society, but materially aid its beneficial labors, by encouraging and assisting, pecuniarily, such valuable experiments as are beyond the means of individuals or of private organizations.

In view, therefore, of the circumstances; we recommend to the favorable consideration of the Society an application to Congress for a national charter, upon the most favorable terms which may consistently be granted; keeping in view mutual advantages between the Society and the country.

Respectfully submitted,

W. Milnor Roberts, Theodore G. Ellis,
Of Committee.

On Nomenclature and Classification of Masonry.

Presented June 15th, 1876.*

The Committee appointed under the following: "*Resolved*, that a committee of three members of the Society be appointed by the President to investigate the varieties of nomenclature and classification used in different parts of the United States to designate the several kinds of stone cutting and masonry and the tools employed in such work, and also the corresponding terms used by French, German and English writers on these subjects, and to inquire into the possibility of securing uniformity of practice in such nomenclature and classification";—

Respectfully reports—that since the appointment on December 12, 1875, its members have not been able to meet for such consultation as would enable them to make a comprehensive report. The pressure of professional engagements, and of preparation for the Centennial Exposition has, as yet, also prevented some of the members from giving to this subject the attention which it requires.

The general scheme of operations under the resolution has been agreed upon, however, and some progress has been made in collecting data; this opportunity is taken to call attention to it, and to request the co-operation of every member of the Society.

One of the greatest difficulties encountered by every committee which has sought to obtain information on special subjects, has been the neglect of members to respond in any way to circular letters, which are, in most cases, the only possible means of communication with persons who can furnish what is wanted. If each member who receives a circular asking for answers to certain questions, would only devote a few minutes, and a postal card to a brief reply on such points as he is most familiar with, the labor of committees would be greatly lightened.

Drawings and descriptions of tools employed, and of classes of masonry have been prepared. The Committee will attach to those the names used by quarry-men, stone-cutters and masons in the localities where they reside, and will send such to members in other

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* The report was accepted and the Committee continued.

places with a request that they will state the names applied in their neighborhood. Specifications, drawings and technical terms, with explanations of the same will be asked for, and also methods of measurement of stone cutting in common use.

Where practicable, specimens of stone from different quarries will be procured, in cubes of 6 inches on a side, with each face differently cut. These specimens will be placed in the museum of the Society.

The collation and comparison of the data obtained by inspection, by correspondence, and from books will be a work involving much labor and considerable time. At present the Committee can only report progress, and request to be continued.

Respectfully submitted.

J. James R. Croes, W. E. Merrill,
E. B. Van Winkle,
Committee.

NOTES AND MEMORANDA.

TESTS OF AMERICAN IRON AND STEEL.

At the Eighth Annual Convention, June 15th last, the annual report* of Committee on Tests of American Iron and Steel was submitted, accepted,† and the Committee requested to prepare an appeal to members of Congress to be sent, with a copy of the report, to each member of the Society.

In compliance therewith the following was submitted :—

So rapid has been the increase in the production of iron and steel in this country, and so varied and multiplied have the uses to which these metals are applied become, that the scientific research necessary to an accurate knowledge of their qualities and a judicious application of these metals, has become a work of such magnitude that it cannot be performed by any private individual or corporation. Such research has therefore not kept pace with the growth of the manufacture of the metals and the multiplication of their uses.

The partial investigations which have been made have resulted in very great benefits. Our government as such, consumes enormous quantities of iron and steel for army and navy purposes and in the construction of public buildings. The officers charged with the application of iron and steel to these purposes are as well informed as to the qualities and characteristics of these metals as any other class of our people, and yet they feel and appreciate the uncertainties through which they are compelled to grope their way to a practice which, if rigidly correct, is so merely by accident.

All the iron and steel makers of the country are painfully conscious of the ignorance which exists, and hail with gratitude the action of Congress appropriating money to remove it. So universal is the use of iron and steel by our people, that all classes are deeply interested in having such accurate knowledge of these metals procured as must lead to safety and economy in their employment. For this reason, a most lively interest has by all classes been manifested in the work of the United States Board to test iron, steel and other metals and the chagrin and disappointment which would mark the failure of the Board for want of the appropriation asked would be correspondingly bitter. Have not the industrial classes a very strong claim upon Congress to have these tests made in their interest, which the Government as such cannot afford to neglect for its own.

Four of the members of the Board are salaried officers of the government, and the remaining three members receive no compensation, except that the Secretary is paid $1,200 per annum for the performance of very arduous duties.

The testing-machine in course of construction for the Board is believed to be the most perfect one ever yet designed. It is now approaching completion. Meantime, the tests and investigations to be made by the Board, have been carefully planned by the various committees appointed to make them. And such of the committees as have been able to work without the machine, are busily engaged and have reached very valuable results. The plans of the Board and its labors thus far have received the hearty approval of the best scientists and practical men of this and other countries, and they have been strongly indorsed by institutions of learning, learned societies, and industrial associations throughout the United States.

The knowledge already obtained by the Board will be worth to the government in a single year many times the amount of the money appropriated, and it must be borne in

* Page 60. † Page 85.

mind that this knowledge once obtained is perennial. If sound economy prompts the expenditure of a small sum of money to save a very large one, it surely demands that Congress shall appropriate the $50 000 asked for the work of the Testing Board during the next year.

The labors of the Board have already resulted in the discovery of a method whereby wrought-iron bars may be made of uniform strength per square inch, whatever is the section. Heretofore that strength has decreased as the size of the bar increased. This discovery is of very great value. They have also led to the rejection of the standard test of the chain cables used in our navy and merchant marine and the adoption of a correct one. The importance of this change will be appreciated when it is known that anchor chains were so injured by the established test that they were upon the point of breaking, and did break when used, from the injury they had received while undergoing test. The great loss of life and property resulting from the failure of the metal parts of bridges, buildings and machinery, can be in very great measure prevented—and will be—by the use of the knowledge which the researches of the Testing Board will develop.

The work of the Board is thoroughly planned, and progressing most satisfactorily. Public safety and economy demand its continuance to completion; and this is now so widely and so well understood that the appropriations necessary will be approved by all classes. On the other hand, the failure of Congress to make them, will result in continual heavy losses to our Government and people, and great and constant danger to life and property.

WM. SOOY SMITH,
Chairman.

SELECTIONS FROM CORRESPONDENCE.

DISCHARGE OF WATER FROM JETS AND IN LONG MAINS.—The accompanying plate exhibits graphically, the quantities of water discharged from jets and in long mains, under different heads.

The horizontal lines are proportional, in distance from *zero*, to the theoretic velocity of a jet of water issuing from that head. Then a series of quantities calculated for any stream at different heads will, on the scale lie on a straight line terminating in *zero*.

The flow of water in long mains of pipes seems to follow the same law, and it is probably applicable to other quantities.

The lower scale represents, in gallons per minute, the flow of water from jets varying from ½ to 3 inches diameter, under heads from 1 to 300 feet.

The upper scale represents in the same manner, the flow in long lines of pipes, from 6 to 26 inches diameter, under heads from 1 to 300 feet per mile.

Similar scales can be constructed, which will give any required number of quantities; that from which this was taken has over 5 000.

Feb'y 15, 1876. GALEN W. PEARSONS.

LAYING MASONRY IN COLD WEATHER.—In answer to inquiries on this subject*—masonry laid in the frost, or where the weather is sufficiently cold to freeze the mortar before it sets, will always settle on the advent of warm weather, in proportion to the thickness of the mortar in the joints collectively.

The difference in temperature at which salt and fresh water freezes is only from 5° to 7°, and therefore, mixing mortar with a solution of salt, is but a small check to the freezing tendency in a climate where the mercury frequently falls four times that much in 24 hours.

The limit at which masonry can be laid in frost, is that at which the stone can be set in the mortar before freezing takes place; sometimes, the mortar is kept hot to prolong this limit of time.

Beyond the settling and the probable derangement of lines, no serious inconvenience results from laying masonry in frost where the walls are thick, but they never should be finished until the frost has entirely left them, in order that there may be an opportunity of adjusting this probable derangement. Piers should not be laid in frost above the water line, but abutments of bridges frequently are, to a limited extent.

Cement mortar is not seriously impaired by being laid in frost, as its property of setting is simply held in suspense during the time it remains frozen.

It will be seen, therefore, that although it is sometimes necessary, it is never desirable to lay masonry in frost where it can be avoided, and that the practice must always be governed by the judgment of the engineer for each special case.

Thin rubble walls, and even brick walls laid in frost, frequently fall on the return of warm weather, owing to the sun's rays first throwing the mortar on the side that is most exposed

* Page 30.

Diagram of water flow in long lines of pipe in gal

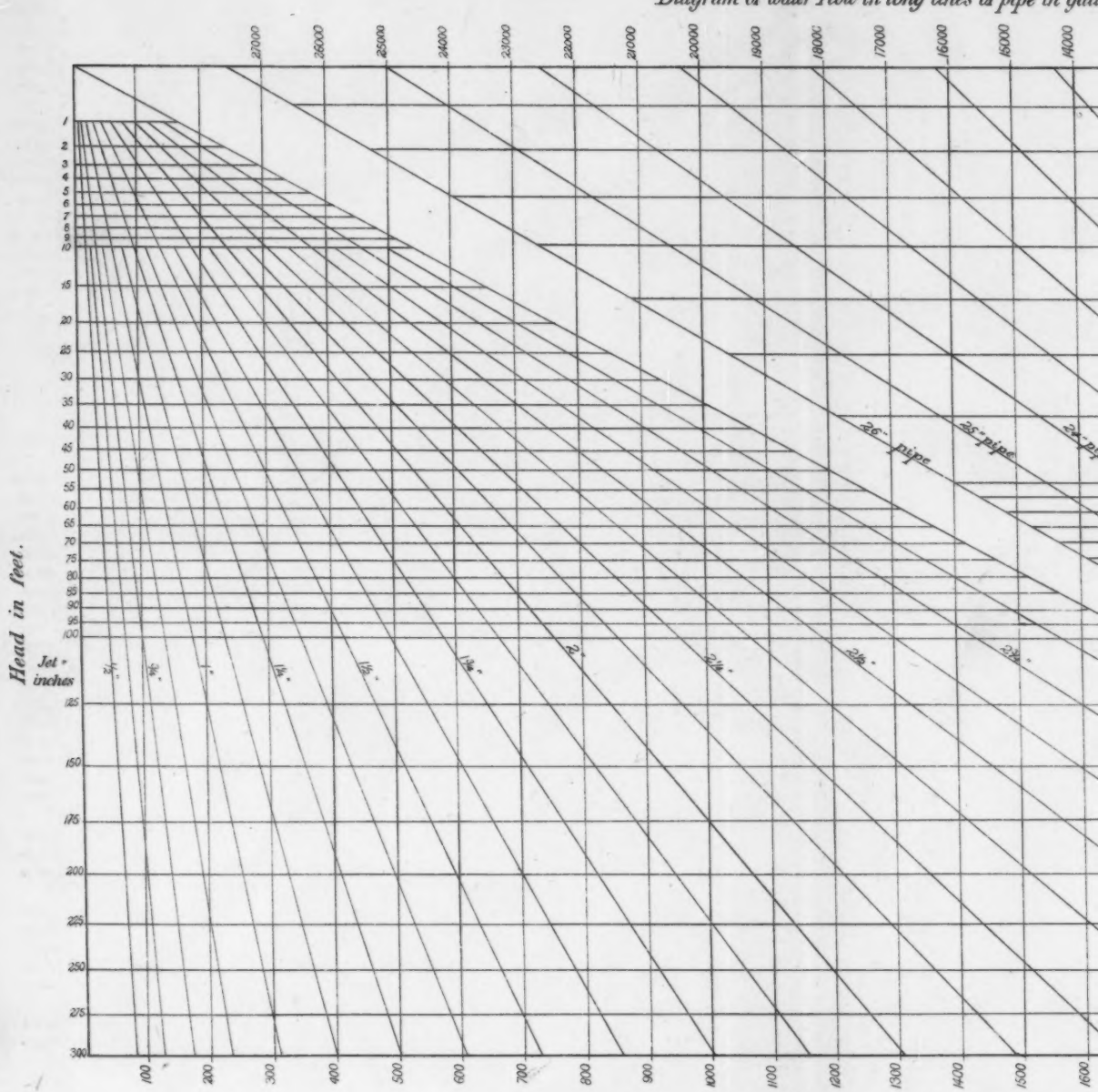
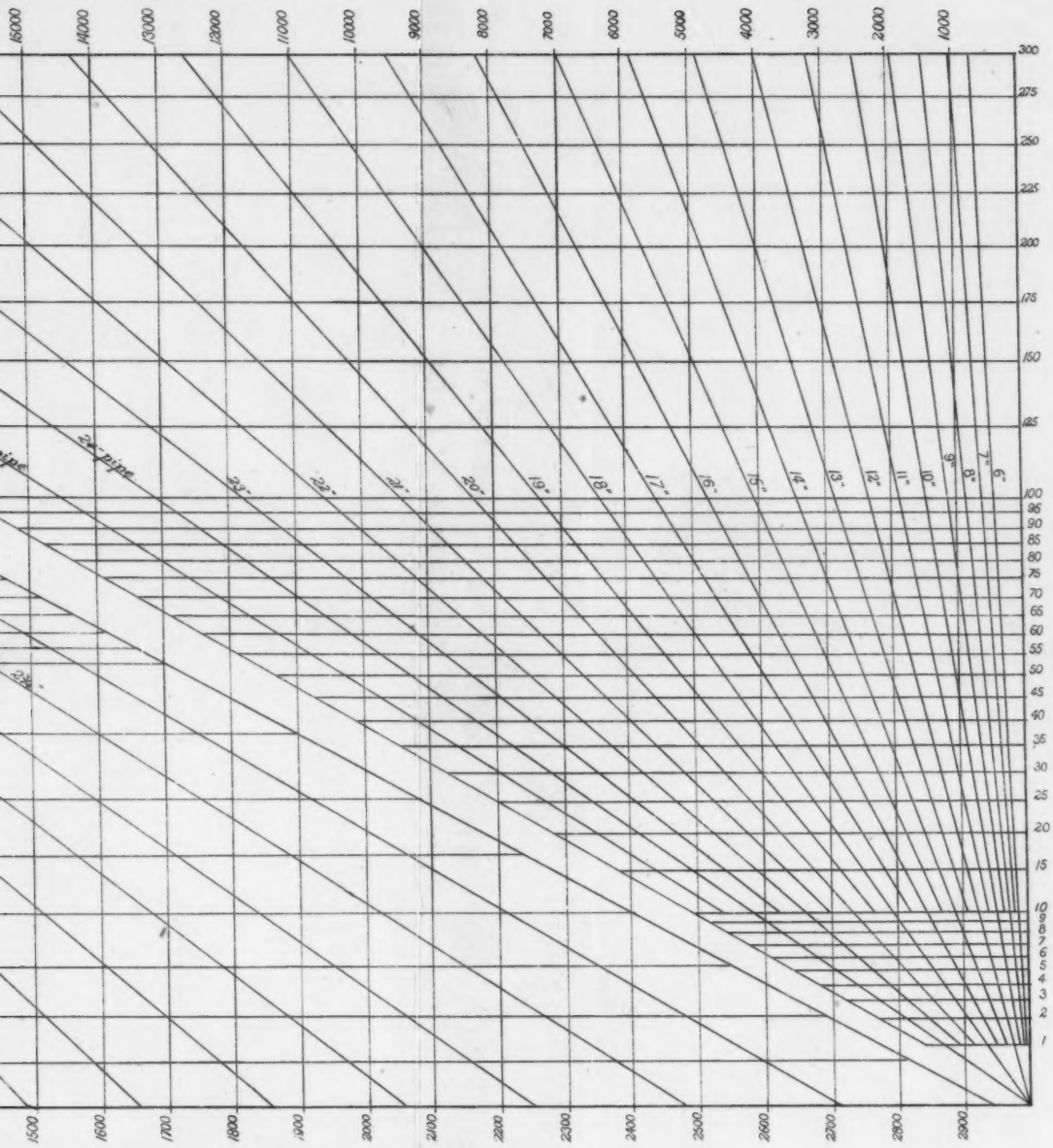


Diagram of discharge of jets in gallons per minute drawn from

AM. PHOTO-LITHOGRAPHIC CO. N.Y. (OSBORN

f pipe in gallons per minute.



Head or slope in feet per mile.

drawn from 94 to 97 per cent theoretical discharge.

APHIC CO. N.Y. (OSBORNE'S PROCESS)

to them, thus causing them temporarily to vary from the perpendicular and lose their centre of gravity.

June 17th, 1876. J. DUTTON STEELE.

COMPRESSED AIR LOCOMOTIVES.—In inviting the attention of the Society to the compressed air locomotive now in use at the St. Gothard tunnel, I shall not attempt more than a general account of the improvement and a reference to its importance; those who desire to investigate the subject will find in the (London) *Engineering* of October 29, 1875, the most detailed account of it that has thus far fallen under my notice.

It consists of an ordinary four-wheeled locomotive of 6¼ tons weight "without any modification to be alluded to," in which a reservoir for compressed air, of 268 cubic feet capacity, and at as high a pressure as possible, takes the place of the steam boiler. To this, is added a small reservoir of 10½ cubic feet, which is connected with the former, by an automatic valve, in which the air is expanded from its variable pressure in the main reservoir to a constant working pressure for the cylinder, and there is also a small reservoir or air cushion between the expander and the cylinders to absorb the shocks of the train.

The automatic reducing valve, by which a constant pressure may be maintained for the cylinders whilst the pressure in the chief reservoir is constantly changing, is the improvement that has solved the problem of using compressed air instead of steam as a propelling power for locomotives. It has also another advantage; the pressure in the subordinate reservoir is regulated by a spring in the reducing valve, which can be tightened or loosened at pleasure, and the power of the engine thus regulated to suit the varying grades of the road where such variation is desirable.

From the popular accounts thus far received, it would seem that the compressing power of the machinery at St. Gothard is 210 pounds per square inch, which is reduced for use in the main reservoir to 105 pounds, and by the reducer into the subordinate or distributing reservoir to 60 pounds, and again by the expansion in the cylinders to 45 pounds. It is, therefore, this last pressure of 45 pounds per square inch, that must be considered with regard to its effect in congealing the watery particles of the atmosphere at the exhaust, which is one of the obstructions to the use of air that has heretofore existed. Our limited experience in this country would indicate that air at that pressure may be exhausted in tunnels without inconvenience, but that in an open Alpine temperature, it would cause an accumulation of ice at the exhaust. We are without information as to the mode of providing against this possible obstruction if it exists, but it is undoubtedly within the range of practical management, and we have the important fact before us, in the absence of details, that at St. Gothard, in an Alpine climate, the air locomotive is working with success.

It is said of it, in Europe, that it "dismisses the important problem of artificial ventilation in long tunnels." In this country it will solve the problem of locomotion upon our street railways; but it is in our mining districts that its advantages will be most largely appreciated. We have already been under the necessity of introducing small steam locomotives into our mines, with their disadvantages of vitiating the air and their danger from fire; all this will be corrected by the use of compressed air, which will aid instead of obstructing ventilation, and substitute safety for danger wherever it is introduced, and that with little or no increase of cost to the operator.

It is hoped that the subject may prove of sufficient importance to claim the attention of such members of the Society as may be thrown in the way of future information, and that they will communicate from time to time the results of their researches.

June 17, 1876. J. DUTTON STEELE.

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

Algebra, elementary — with numerous Exercises. David Munn. London. 12mo. *Collins.* 2s. 6d.

Animals and Plants, geographical Distribution of— Part 2: Plants in their wild State. Charles Pickering. Salem. 4to. illus.

—— Geographical Distribution of —— with a Study of the Relations of living and extinct Fauna, as elucidating the past Changes of the Earth's Surface. Alfred R. Wallace. 2 vol. London. 8vo. illus. *Macmillan & Co. (New York.)* 42s.

Architecture, Lectures on—. E. Viollet-le-Duc. Trans. from the French by Benjamin Bucknall. Part 1. London. 8vo. illus. *Low.* 10s. 6d.

Art, Persian —. R. Smith. 8vo. illus. *Chapman & Hall.* 1s. 6d.

Astronomy, Handbook of —. Dyonesius Lardner. Rev. and comp. to 1875, by Edwin

Dunkin. London. 8vo. illus. *Crosby, Lockwood & Co.* 9s. 6d.

Boiler Explosions in Steam Vessels. Papers relating to Experiments. Parliamentary Report. London. 8vo. 6d.

Book keeping, a practical Guide to Double-Entry —— in tabular Form, and commercial Calculations adapted to the Comprehension of Everybody. M. M. Sommer. New York. 8vo. *Dennis.* $0.75.

Botany. Iconos Plantarum; or, Figures, with descriptive Characters and Remarks, of new and rare Plants, selected from the Kew Herbarium. J. D. Hooker. London. 8vo. illus. 3d series. Vol. 2. *Williams & Norgate.* 32s.

Building. The Clerk of Works, a Vade Mecum for all engaged in the Superintendence of Building Operations. George Hoskins. London. 12mo. *Spons.* (*New York.*) $0.60.

Coal Mining. Mining Engineering, a practical Treatise on Coal Mining. G. G. Andre. Part II. 4to. illus. *Spons.* (*New York.* $2.00.

Computations, Principles of approximate —— Joseph J. Skinner. New York. 16mo. *Holt & Co.* $1.25.

Design, Studies in —. Chr. Dresser. London. Folio. *Cassell.* 63s.

Drainage, Defects in House —— and their Remedies. Edward S. Philbrick. Boston. 8vo. illus. (*New York. Van Nostrand.*) $0.25.

Eclectic Engineering Magazine, Van Nostrand's. Vol. 14, January to June, 1875. New York. 8vo. illus. *Van Nostrand.* $3.00.

Engineers, Transactions of the Society of —— for 1875. Ed. by Perry F. Nursey. London. 8vo. illus. *Spons.* (*New York.*) $6.00.

Industrial Arts, historical Sketches of the —— ——. London. 8vo. illus. *Chapman & Hall.* $1.50.

Iron and Steel: a Work for the Forge, Foundry, Factory and Office, containing ready, useful and trustworthy Information for Ironmasters and their Stocktakers; Managers of Bar, Rail, Plate and Sheet Rolling Mills; Iron and Metal Founders; Iron Ship and Bridge Builders, mechanical, mining and consulting Engineers, Architects, Contractors, Builders and professional Draughtsmen. Charles Hoare. London. 12mo. obl. illus. *Crosby, Lockwood & Co.* 6s.

Man, the 5 Senses of ——. Julius Bernstein. London. 8vo. illus. (International Science Series.) *Henry S. King.* 5s.

—— a philosophical Treatise on the Nature and Constitution of ——. George Harris. 2 vols. London. 8vo. *Bell & Sons.* 28s.

Manufacturing Industries, British. Ed. by G. Phillips Bevan. Vol. VII. Paper by Prof. Archer; Printing and Book-Binding, by Joseph Hatton; Engraving, by Samuel Davenport; Photography, by P. le Neve Foster; Toys, by George C. T. Bartley. Vol. VIII. Tobacco, by John Dunning; Hides and Leather; Gutta Percha and India Rubber, by J. Collins; Fibers and Cordage, by P. L. Simmons. London. 12mo. illus. *Stanford.* (*New York. Van Nostrand.*) Each $1.75.

Meter Diagrams, illustrating the metric System, with Explanations. Tables of Length, Surface, Capacity and Weight. Rules, approximate Equivalents. &c. A. & T. W. Stanley. 16mo. New Britain.

Mississippi River. Report on the Inspection of the South Pass Improvement of the Mouth of —— ——. June 9, 1876. C. B. Comstock, Washington. 8vo. maps. *Eng. Dept.*

Money, Paper ——. Inflation in France: how it came, what it brought, and how it ended. Andrew D. White. New York. 8vo. *Appletons.* $0.50.

Motion, Vital ——, as a mode of physical Motion. Charles B. Radcliffe. London. 8vo. *Macmillan.* (*New York.*) $2.50.

Natural History Objects. Notes on Collecting and Preserving.—Ed. by J. E. Taylor. London, 12mo. *Hardwicke & Bogue.* 3s. 6d.

Naval Powers and their Policy, with tabular Statements of British and Foreign Iron Clad Navies, &c. John C. Paget. London. 8vo. (*New York, Van Nostrand.*) $5.25.

Navigation: a Lecture delivered in City Hall, Glasgow, Nov. 11, 1875. William Thomson. London. 12mo. *Collins.* 6d.

—— Definitions and Explanations of —— and Nautical Astronomy, for Use of Naval Cadets on Board H. M. S. Britannia. Portsmouth. 8vo. *Griffen.* (*London. Simpkin.*) 2s. 6d.

Patents, a brief Treatise on United States —— for Inventors and Patentees. Henry Howson and and Chas. Howson. Philadelphia. 16mo. *Porter & Coates.* $1.00.

—— General Index of the Official Gazette and monthly Volumes of Patents of the U. S. Patent Office, for 1875. Washington. 8vo. *Gov't Printing Office.*

Physical Manipulation, Elements of ——. Edward C. Pickering. Part II. Boston. 8vo. illus. *Hurd & Houghton.* $4.00.

Plumbing: a Text-Book to the Practice of the Art or Craft of the Plumber; with supplementary Chapters upon House Drainage, embodying the latest Improvements. William P. Buchan. London. 12mo. illus. *Crosby, Lockwood & Co.* (Announcement.)

Railways. Accidents. Part 7. August to December. 4s. 10d. Part 8. November, December. 1875. 3d. Parliamentary Report. London. 8vo.

—— Parliamentary Report on Abbots Ripton Accident. London. 8vo. 2s. 6d.

Riflemen, the Forest and Stream Handbook for —— giving Forms for Organization of Rifle Associations, By-Laws, Rules for Practice and Competition, practical Hints concerning Ranges, Targets, Scoring, Rifles, Shooting, etc.; and a List of Rifle Associations in America. George O. Starr. New York. 18mo. illus. *Ford.* $0.50.

Sanitary. The Public Health Act, 1875, arranged in Dictionary Index Form; being a Handy Book for ready Reference, for the Use of Officers and Members of Sanitary Authorities. James C. Stevens. London. 8vo. *Shaw & Sons.* 7s. 6d.

—— The late Visitation of Typhoid Fever in the School and Town of Uppingham; a Statement of the Action of the sanitary Committee and Reports of the medical Officer and the Engineer. London. folio. illus. (*New York. Van Nostrand.*) $1.00.

Screw Casing. Reports respecting —— —— in the Navy. Parliamentary Report. London. 8vo, illus. 1s.

Telegraph Engineers. Journal of the Society of —— including original Communications

on Telegraph and electrical Science. Ed. by Frank Bolton and J. Sivewright No. 11. 8vo, illus. *Spons.* (*New York.*) $2.00.

Ventilation. Report on— of House of Representatives and the South Wing of the Capitol of United States, to the Commission of Enquiry. Robert Briggs. Philadelphia. 8vo. *Ashmead.*

Vivisection. Evidence given before the Royal Commission on——. George R. Jesse. London. 12mo. *Pickering.* 2s. 6d.

Water Witching. The divining Rod. Charles Latimer. Cleveland. 12mo.

—— Works. Notes upon the —— —— of Philadelphia, 1801-15. F. Graff. Philadelphia. 8vo.

ADDITIONS TO

LIBRARY AND MUSEUM.

NOTE: "Copies for distribution" named in this list will, in order of receipt, be sent to members who apply, until the supply is exhausted.

DONATIONS ARE ACKNOWLEDGED AS FOLLOWS:

From G. W. R. Bailey, New Orleans, La.:

Jetties at Head of South Pass. Map of Head of Passes, Mississippi River. 3 sheets.

From Robert Briggs, Philadelphia:

Report on the Ventilation of the Hall of Representatives, and of the South Wing of the Capitol of U. S., to Commission of Inquiry. Robert Briggs, Philadelphia, 1876.

From E. S. Chesbrough, Chicago:

Annual Report of the Board of Public Works, City of Chicago, for 1875. Chicago.

From Frederick Graff, Philadelphia:

Notes upon the Water Works of Philadelphia, 1801-1815. (Copies for distribution.)

From Maj. P. C. Hains, Light-House Board, Washington.

Annual Report of Light-House Board, for 1875, Washington. 2 copies.

Drawings and specifications as follows: for Day Beacons for Potomac River, 2 plates; for a Keeper's Dwelling for a First-Order Light-House; for Light-House for South-West Ledge, Long Island Sound, 13 plates; for Light-House on Fowey Rocks, Florida, 22 plates. (All in duplicate.)

From G. A. Kimball, Somerville, Mass.:

City of Somerville—Annual Reports, 1875. Boston.

From C. Latimer, Cleveland, O.:

Atlantic & Great Western R.R.—Comparative Statement of Expenses in Engineering Department, March 1875-6 (2 Tables);

The Divining Rod. C. Latimer, Cleveland.

From W. J. McAlpine, Babylon, N. Y.:

Message and Documents—War Department, 1869-1874. 10 vols. Washington.

Reports of Explorations and Surveys to ascertain the Practicability of a Ship Canal between the Atlantic and Pacific Oceans, by Way of the Isthmus of Darien, by T. O. Selfridge, and by Way of the Isthmus of Tehuantepec. R. W. Schufeldt. 2 vols. Washington.

Reports on Water Works of New Bedford, Salem, Charlestown, &c.

Report of Acushnet Water Board, New Bedford Water Works, for 1870, '71, '76 and and '75. New Bedford. 4 vols.

Report of Department of Public Works of New York, for Year ending April 30, 1872.

From C. Paine, Cleveland, O.:

Report of J. H. Devereux, Receiver of Atlantic and Great Western R.R., from Dec. 10, 1874 to Dec. 31, 1875. Cleveland.

From Theodore R. Scowden, San Francisco, Cal.:

Proceedings and Reports on furnishing Water Supplies for San Francisco. (Copies for distribution.)

From T. S. Sedgwick, Washington:

Arguments before Senate Committee on Military Affairs referring to Lease of Goat Island for a Railway Terminus.

Chesapeake & Ohio R. R.; its Advantages as a Route between the Seaboard and the West. May, 1873, New York.

Great Southern Trans-Oceanic & Inter-National Air Line. Asia to Europe, via Mexico and the Southern States. Philadelphia, 1873.

Irrigation—Wells in the Desert. Speech of Charles W. Kendall in the House of Representatives. March 23, 1872. Washington.

Letter from the Secretary of War, January 14, 1871, relating to Survey and Improvement of Ohio River.

Memorial of Board of Commissioners suggesting a Method for Improvement of Ohio River.

Notes of a Military Reconnoissance from Fort Leavenworth to San Diego, including Parts of the Arkansas, Del Norte, and Gila Rivers. Washington, 1848.

Reports as follows:

Of Board of Engineers on Newport and Cincinnati Bridge, &c., December 21, 1870.

Of Board of Engineers upon Bridges across the Ohio River.

Of the Board of Railroad Commissioners, Mass. Boston, 1871.

Of Chesapeake & Ohio R. R. Co., 1871. New York.

Of Commissioners of City Works of City of Brooklyn, for 1872. Brooklyn.

Of Nassau Water Department of City of Brooklyn, for 1871. Brooklyn.

Of Surveyor-General of the Land Office for Wyoming.

The San Joaquin and Sacramento Valleys of California; a great Irrigation Scheme.

Treatise on practical Astronomy, S. Vince. Cambridge, 1790.

Ziegler's Patent Prismatic Block Pavement; Circulars and Letters.

From J. W. Smith, San Francisco, Cal.:

Act for Appointment of Commissioners of Transportation of California to fix Freights and Fares on Railroads.

From T. Guilford Smith, Buffalo:

Annual Registers of Rensselaer Polytechnic Institute. Troy, N. Y., 1873-4 and 1874-5.

Argument of Franklin B. Gowen in behalf of Phil. & Reading Coal & Iron Co., and Phil. & Reading R. R. Co., at Atlantic City, July 29, 30, 1875. Philadelphia.

—— John Q. Lane and Silas W. Pettit against Phil. & Reading Coal & Iron Co., and Phil & Reading R. R. Co. July 28-31, 1875. Philadelphia.

British Treaties of 1871-74. Letters by H. C. Carey. Philadelphia, 1874. (2 copies.)

Concerning the Cost of Transportation on Railroads. L. P. Morehouse. New York, 1874.

Cost of Railroad Transportation, Railroad Accounts and Governmental Regulation of Railroad Tariffs. Albert Fink. Louisville. 1875.

Currency Inflation; how produced and to be reduced. H. C. Carey. Philadelphia, 1874.

Description of Coal and Iron Exchange Building. New York, 1876.

National Self-Protection. Joseph Wharton. Philadelphia, 1875.

"Penn. Monthly," Oct., 1871. April, 1872. Philadelphia.

Proposals for Wrought and Cast Iron Work for the U. S. Post Office and Sub-Treasury, Boston, Mass.

Proposed Reciprocity Treaty. Address by William D. Kelly. Philadelphia, 1874.

Report of Interview between Manufacturers and House Committee of Ways and Means. Philadelphia, 1874.

Reports of Philadelphia & Reading R. R. Co., for 1873. Philadelphia. (3 vols.)

Statistics and Information relating to Trade and Commerce of Buffalo, 1872-74. Buffalo. 2 vols.

Specification for City Hall, Hall of Records and Law Courts, San Francisco, Cal.

Treatise on Elements of Mechanics. John W. Nystrom. Philadelphia.

20th—21st Annual Reports of Boston Board of Trade. C. G. Attwood. Boston, 1874-75.

Value of proposed International Exhibition. Speech of William D. Kelly. Washington, 1874.

Western Farmers' Benefit by Protection. David H. Mason. Chicago, 1875.

From St. Louis Bolt & Iron Co., St. Louis, Mo.:

Specimen Book, with Plates. (2 copies.)

From U. S. Patent Office, Washington:

General Index of Official Gazette and Monthly Volumes of Patents of the Patent Office—Official Gazette and Monthly Volumes, Jan. to Dec. 1875.

From D. Van Nostrand, New York:

Fatigue of Metals under repeated Strains—with Results of Experiments. L. Spangenburgh and S. H. Shreve, New York, 1876.

High Masonry Dams. J. B. McMaster. New York. 1876.

From J. D. Van Buren, Jr., Albany:

Act relating to Appointment and Duties of Engineers employed on Canals of the State of New York.

Laws and Regulations of the Engineer Department of the State of New York. 1868. Albany.

From W. W. Wood, Engineer-in-Chief, Navy Department. Washington:

Report of Board to recommend a Standard Gauge for Bolts, Nuts, and Screw-Threads for the U. S. Navy, May, 1868. Washington, 1875.

From Miscellaneous Sources:

Golden Book of celebrated Manufacturers and Merchants in the U. S. New York. 1876.

Report of the New York City Council of political Reform for 1875.

Seventh Annual Report of State Board of Health of Massachusetts. January, 1876. Boston.

Stanley's Meter Diagram—illustrating the metric System, with Explanations, Tables of Length, Surface, Capacity, &c. New Britain.

ANNOUNCEMENTS.

MEETINGS.—No regular or stated meetings of the Society will be held from July 5th, to September 6th.

PAPERS RECEIVED for presentation to the Society are announced as follows:

Report of Committee on Tests of Iron and Steel. W. Sooy Smith, Ch'm. May 11, 1876.

Reports of Committee on Uniform Method of Gauging Streams. Theodore G. Ellis, Ch'm. May 30, 1876.

Railroad Accounts and Returns. William P. Shinn. June 2, 1876.

Discussion by Albert Fink and A. D. Briggs. June 13 and 17, 1876.

"Notes and Suggestions on the Croton Water Works and Supply for the Future." Discussion by Joseph P. Davis. June 5, 1876.

"Erection of the Verrugas Bridge." Discussion by Virgil G. Bogue and by Lefferts L. Buck. June 15, 1876.

Qualities of Iron and Steel. William Metcalf. June 15, 1876.

"Metric System of Weights and Measures." Discussion by Theodore G. Ellis. June 15, 1876.

Final Report of Committee on Form, Weight, Manufacture and Life of Rails. Ashbel Welsh, Ch'm. June 15, 1876.

Report of Committee on Nomenclature and Classification of Masonry. J. James R. Croes, Ch'm. June 15, 1876.

Report of Committee on Failure of the Dam at Worcester, Mass. Theodore G. Ellis, Ch'm. June 15, 1876.

Report of Committee on Resistances of Railway Trains. William P. Shinn, Ch'm. June 15, 1876.

A cheap Transfer Table. William P. Shinn. June 5, 1876.

Gauging of Streams, a special Case. David M. Greene. June 10, 1876.

"Notes on the Improvement of the Mouth of the Mississippi." Discussion by Charles W. Howell. June 13, 1876.

Report of Committee on Securing National Recognition of the Society. W. Milnor Roberts and Theodore G. Ellis. June 14, 1876.

"The New Portage Bridge." Discussion by Charles Macdonald. June 15, 1876.

"Levees as a System of Reclaiming Low Lands." Discussion by G. K. Warren and Charles G. Forshey. June 15 and 17, 1876.

Cut-offs on the Mississippi River, their Effects on the Channel, above and below. Charles G. Forshey. June 17, 1876.

Laying Masonry in Cold Weather, and—

Compressed Air Locomotives. J. Dutton Steele. June 17, 1876.

PAPERS FOR THE NORMAN MEDAL should be presented before September 1st next. The Conditions of Award are set forth in the Code of Rules heretofore published in the Journal; a copy will be furnished to applicants.

DONATIONS TO THE LIBRARY.—Members and others are asked to contribute regularly to the library of the Society, copies of government, municipal, railway, canal and other reports, specifications, profiles, maps, photographs and like matter, making up the record of engineering operations for the past or present, and to inform the Secretary where such may be had. Duplicate copies are desired, for transmission to foreign societies in return for works collected and sent to this library by them; also for exchange with members and others who wish complete sets referring to particular subjects. In order to gather material now considered but of little value, but of great future importance in the history of the public works of this country and a comparison of their economical results, donations are solicited of old reports or pamphlets, which in any way refer to construction or operation.

THE FRANKLIN INSTITUTE has opened a reception room at the northwestern end of Machinery Hall, Centennial Exhibition, for the use of its members and visitors from abroad, interested in the mechanic arts. This Institute cordially invites all to visit this room, in which will be found files of the Journal of the Institute and of other periodicals devoted to the industrial arts. The room is in charge of a Committee of 30 members of the Institute, one or more of whom will be in attendance daily, during the Exhibition, to receive visitors and give information.

The following objects of great historical interest have been placed in the room:

1st. Franklin's Electrical Machine.—This instrument is doubtless the one used by the great philosopher in making his wonderful experiments in the science of electricity.

2d. Oliver Evans' Steam Locomotive Engine.—This interesting model is among the earliest known, having been built about 1804.

3d. Oliver Evans' High Pressure Steam Engine.—This is the model of an engine built by him about 1804, and is described in Galloway's work on the Steam Engine, London, 1827.

4th. Working Model of a Steam Engine, built by M. W. Baldwin, and presented to the Institute about 1832.

CARD TO MEMBERS.—The following is from a circular issued December 10th, 1872.

"The Society should be of real and positive benefit to each member; that this in one way may result, the Secretary will endeavor to obtain experimental knowledge from experienced members, upon matters of practice, for those who request it; examine in the public libraries authorities upon special topics, select books, instruments and similar 'material' for an engineer's equipment, and to execute other commissions within his province, of a professional character. Those seeking engagement and those requiring engineering service are desired to communicate to him the particulars, that such may be brought together; and generally, all interested are urged to aid in rendering the offices of the Society a bureau of professional information to its members."

Members thus commanding the Secretary are requested to state explicitly what is required, and he will endeavor to execute their commissions with reasonable promptitude, *without charge.*

PHOTOGRAPHS OF MEMBERS.—By resolution of the Society, each member has been requested to furnish two photographs of himself, of the usual card size, as a means of promoting social recognition and intercourse. Those who have not complied with this request are specially asked to aid in making the collection complete, by speedily forwarding their photographs, endorsed with autograph and date.

THE ROOMS OF THE SOCIETY are on the south-east corner of Broadway and Twenty-third street, nearly opposite Fifth Avenue Hotel, and overlooking Madison square; entrance, 4 East Twenty-third street. Members—particularly those from out of town—are invited to make these rooms their headquarters. Appointments with other parties may be kept here, and for such and similar personal matters a private room may be had.

LIST OF MEMBERS.

ADDITIONS.

BROOKS, FREDERICK [J.].Ass't Eng., Newton Water Works, Boston, Mass.....June 17, 1876.
BURR, JAMES D.....Res. Eng. C. S. R'y, Smith's Cross Roads, Tenn..... " 19, "
DOANE, EDWIN A.....Sup'g Eng. L. O. D'n. R. W. & O. R. R., Oswego, N. Y..... " " "
LATIMER, CHARLES.....Ch. Eng. A. & G. W. R'y, Cleveland, O..... " 27, "
SWEET, WILLIAM A.....Pres., Sweet M'f'g Co., Syracuse, N. Y. " " "
WHITTEN, NATHAN H..Eng., Holyoke Water Power Co., Holyoke, Mass..... " 17, "
WILSON, JOHN A.....Civ. Eng. and Arch., 410 Walnut St., Philadelphia, Pa..... " 19, "

CHANGES AND CORRECTIONS.

ALDRICH, JAMES C.....As't. Eng. Dep't Public Parks, 36 Union Sq. (East), New York.
BURR, WILLIAM H.....Rens. Pol. Institute, Troy, N. Y.
FALCONNET, EUGENE F..Ch. Eng. C. & O. R. R., Lebanon, Tenn.
GILLESPIE, JOSHUA L....U. S. Engineer's Office, St. Paul, Minn.
HAINES, CASPAR W.....P. O. Box 938, Altoona, Pa.
KNIGHT, WILLIAM B.....South Natick, Mass.
LOW, GORHAM P., Jr....As't Eng., Boston Water Works, Framingham, Mass.
MCALPINE, CHARLES L..(Care Am. Soc. Civil Eng's), New York.
MCALPINE, WILLIAM J..Babylon (L. I.), N. Y.
NORTH, EDWARD P.....(Care Am. Soc. Civil Eng's), New York.
PETERSON, PETER A.....Ch. Eng. Q. M. O. & O. R'y, Montreal, Canada.
RINECKER, FRANCIS.....Wuerzburg, Germany.
SCHOTT, CHARLES R.....Div. Eng. Dep't Public Parks, 106 E. 74th st., New York.
SMITH, ISAAC W.....State Commissioner of Transportation, Cosmopolitan Hotel, San Francisco, Cal.
WARD, CHARLES D.....Madison, N. J.
WILSON, JOSEPH M.....410 Walnut st., Philadelphia, Pa.

DECEASED.

POINIER, P. PORTER [J.], late of Cambridge, Mass.....June 11, 1871.

American Society of Civil Engineers.

PROCEEDINGS.

Vol. II, July, 1876.

MINUTES OF MEETINGS.

(Abstract of such as may be of general interest to members.)

OF THE SOCIETY.

JUNE 21ST, 1876.—In absence of a quorum, no stated meeting was held.

JULY 5TH, 1876.—A regular meeting was held at 8 o'clock, P. M.

The vote on the admission to membership was canvassed and the following declared elected:—Members—George W. Dresser and C. Vanderwort Smith of New York, and Charles F. Hillman, of Chili, S. A.

The death, on June 11th, of P. Porter Poinier, a Junior admitted March 9th, 1875, was announced, and Robert H. Thurston and DeVolson Wood were appointed a committee to present to the Society a memoir of the deceased.

OF THE BOARD OF DIRECTION.

JULY 5TH, 1876.—In absence of a quorum, no stated meeting was held.

NOTES AND MEMORANDA.

SELECTIONS FROM CORRESPONDENCE.

DAMS FOR RESERVOIRS.—In regard to the construction of earthen dams for reservoirs; below is a copy of the specifications for restoring the earthen dam at Worcester. These are full enough to explain my views of how an earthen dam should be built.

I have a letter from one of our most experienced and judicious members, in which he says: "It is a mortifying fact that so many of the dams built by our engineers in this section have failed, though those built by farmers and mill-owners stand safe."

Another said to me: "It is an accident if any earthen dam which has a 'spiling wall' does not fail." And another, referring to river dams of stone or wood, said: "They can never be considered safe until they have been twice carried away" (*i. e.*, at each end).

Earthen dams rarely fail from any fault in the artificial earth work and seldom from any defect in the natural soil. It, the latter, may leak, but not to endanger the dam. In nine-tenths of the cases the dam is breached along the line of the water outlet passages.

The "spiling walls," which are put in so many earthen dams, extending the whole length of the embankment and form a base into the tight natural soil and up to a level above the water in the reservoir, is usually made of rubble stone laid in cement with smooth faces.

Such walls will not perceptibly settle, but the best built puddle placed alongside will settle considerably, and there will always be a vertical crack along the whole length and height and at both faces of the wall.

If there should happen to be any place in the upper half of the dam which leaks, these cracks will conduct the water to an indefinite distance along, under and on both sides of the wall, to some leaky portion in the lower half where the water can escape.

A mere film of water is sufficient to carry the whole pressure (not volume) from the lake, and the water escaping in muddy sweat drops is gradually carrying with it the light soil in solution and enlarging the passage until an increase of quantity takes up the earth in suspension, and the orifices are then rapidly enlarged and a breach threatened.

Hence such cut-off walls become sources of danger. The two materials (masonry and earth) should not be used together if it can be avoided, or if so used, extraordinary care should be taken to prevent even a film of water along the line of union.

The outlet passages must be of masonry or of iron, and should rest on and be enveloped in masonry, and extending transversely through the dam is a source of peculiar danger.

Water in motion "abhors an angle" and any head can be destroyed by forcing the water to turn a sufficient number of abrupt angles, at each of which the velocity is lessened, the quantity (leakage) is less, the "solution" or "suspension" is less and the danger of breakage is diminished and, with a sufficien number, is prevented.

Wherever walls of masonry are in contact with earth a film of water communicating with that in the reservoir is liable to occur. The surfaces of these walls should be made as rough and irregular as possible to produce as many of these angles as possible.

The puddle walls are always founded into a trench in the natural soil which should be broken up, and it should also be "toothed" both horizontally and vertically when the wall is *stepped* up on the sides of the ravine.

Under the whole base of the embankment, or, at least, that portion from under the lower top angle to the foot of the water slope, should be prepared by removing the pervious or decaying matter by breaking up the natural soil, and by stepping up the sides of the ravine, but also by several "toothed" trenches across the bottom and up the sides.

Forty years ago, Mr. Jervis introduced the modern system of building earthen banks, but before that time the "old school" engineers built earthen dams which rarely failed. Our modern practice requires the artificial earth work to be made with extraordinary care, but then it must always be based upon the natural soil. Now we take this same soil, select it carefully, moisten and compact it at great expense, and yet it is subjected to less pressure than the underlaying natural soil. Is all this care necessary? I never heard of a case where a dam failed from an imperfection in the artificial earth work, even if built by a "farmer." Leakages and destruction come from an imperfect connection between the artificial and natural earths.

The failures of earthen dams from overflow are not uncommon. No such dam is safe unless it has an overflow long enough to discharge the heaviest rain fall (increased by melting snow) without resort to the manual operation of opening gates, etc, before the water can raise to within 3 to 5 feet of the top of embankment. The attendant may be taken suddenly sick, or may be absent or sleepy, and the dam is destroyed.

April 28, 1876. WM. J. McALPINE.

SPECIFICATIONS for repairing the break in the dam of the storing reservoir for the Worcester water works, on Lynde brook, in the town of Leicester.

General description.—The former dam was made of 50 feet width on top, and slopes on each side of two horizontal to one vertical, and 40 feet above the base. It was arranged that it could be hereafter built to a level 5 feet higher, which would have reduced the top width to 30 feet. Although the dam now remaining is of unnecessary width on the top, yet for appearance sake the same outlines will be maintained in the new work of repairs.

The space opened by the breach will be filled with an earthen embankment, in the middle of which will be a puddle wall, and transversely through the bank will be placed three lines of cast iron pipes resting upon and enveloped in a wall of rubble masonry and connected with three cast-off walls of masonry. At the upper end of the pipes, near the foot of the upper slope, will be erected a regulating gate house, and near the foot of the lower slope, a gate well, both of rubble masonry.

The upper face of the new embankment will be protected by a slope wall pavement of the same character as that now upon the face of the old dam. The present waste way will be maintained as heretofore, except that the provision for the insertion of flash boards will be removed. The new gate house will be arranged to act also as an additional waste way, discharging at the same level as the present weir.

The important features in the restoration of the dam consist:

First.—Of the removal of the whole of the bottom part of the former "spiling walls."

Second.—Of cutting off 6 feet in length of the original supply and waste pipes directly under the new puddle wall.

Third.—The founding of the bottom of the new puddle wall into the water-tight original soil by toothing, as shown on the plans, and by jutting vertically and horizontally into the steps with the same toothing. Where the former banks are found to be of good material and to have been carried down into water-tight natural soil, and when such banks have not been disturbed by cracks and slides, they are to be considered as equal to the natural banks, and the puddle wall is to be founded, toothed and stepped into them, as before mentioned, for the water-tight natural earth.

Fourth.—The new embankment above the centre line of the dam will be founded by stepping into toothing and jutting, as described for the puddle wall, but to a less extent; that is, the jutting may be made at intervals of 10 feet (transversely to the line of the embankment), and from 2 to 4 feet deep and back into the present banks.

The stone for the gate house and gate well should be of sound, durable, well shaped and large sized stone, such as will make good rubble masonry, and give a good, fair, regular face on the outside and inside of the gate house and well. The whole to be well bonded and laid up compactly in mortar of hydraulic cement. The waste or overflow at the level of top water in the reservoir may be made of the cut stone blocks from the old gate house, and any surplus of such cut stone may be laid for the quoins of the upper portion of the well. The foundation of the gate house, should be made of sound, durable timber and plank, placed at such depth as to be always wet.

Seventh.—The selection of the material should commence at the borrow pit by using the best of the material, breaking up the lumps and throwing aside all stones of more than 2 inches in diameter. When the earth is deposited alongside of the puddle wall, the same selections and breaking up is to be continued, and again when it is strewn.

The puddle wall should be made as follows: The selected materials deposited (the clay soil on one side and the fine gravel on the other side) along the wall should be distributed by strewing thin layers with the shovel, giving the proper proportion of each by having three men strew the clay and one the gravel, and a fifth man sprinkling with water (being careful to avoid any excess of water), until a depth of 6 inches is obtained.

When the puddle stuff has been thus prepared and tempered with water, it is to be cut and cross-cut with spades, in cuts of not exceeding one inch in width, taking care that the spades are forced down into the lower course of puddle to thoroughly incorporate the whole mass.

In rainy weather, or when too much water has been used, so as to make the puddle quake like jelly, it must be allowed to remain undisturbed until the excess of water is carried off by absorption and evaporation. Whenever a course of the puddle is finished, and before it can sun-crack, a fresh layer of puddle material must be put on, and whenever the puddle has stood so long as to have lost its moisture, it must be wet and recut before an upper course is laid on. Carts must not be allowed to pass over the puddle except where planks are laid down.

The puddle wall must be commenced in the lowest place and be carried up in level courses, but the adjacent embankment must always be built up at least 6 inches higher than the puddle wall.

If necessary (to be avoided if possible) to carry up the puddle higher in one place than in another, it must be done by racking back in steps of not more than 6 inches depth nor less than 2 feet tread (4 to 1).

Eighth.—The upper half of the embankment (made of the selected materials before mentioned) must be built up in level courses of not exceeding 4 inches thickness, spread evenly by strewing with the shovel and moistening to a proper consistency. The lumps must be broken up fine at the borrow pit, at the dump and when strewn, and a careful selection of the material must be made at each place. The embankment must be commenced at the lowest place, and always be maintained nearly level in both directions, and, if necessary to be built up higher in one place than another, it must be racked back in steps equal to 1 in 4.

The under part of the embankment for 10 to 15 feet high may be made with wheelbarrows; but whether made with carts or bar-

rows each layer must be thoroughly rolled with heavy, grooved rollers before the succeeding one is put on. That portion of the embankment immediately adjoining the puddle wall should be made almost as compact as the puddle wall, and at 10 or 15 feet distant it should taper off in compactness to that of the remainder of the embankment. The lower half of the embankment will be made with the best materials and care, adjacent to the puddle wall, and less care toward the lower slope. The pavement wall on the upper slope has been previously described. It may be laid directly upon the earthen embankment.

Ninth.—The gate house shall be made 8 by 6 on the inside, with walls 4 feet thick at the bottom, and 2½ feet at the level of top water in the reservoir, and above this there will be arranged a foundation to the house by four brick arches, through which water will flow and wash into the well. The upper house may be of wood or brick, and having access by a small wooden bridge to the top of the embankment. The foundation of the gate house will be 18 by 16 feet of pine timbers about 8 by 12 inches, covering half the area, and covered with 2 inch pine plank. The outside wall will be provided with three small waste holes of one foot square, closed with a a 3 inch plank placed on the foundations. The inlet gates will be of cast iron 2 by 3 feet, sliding vertically on cast iron frames, three of which will be placed on the upper face of the gate house wall, and protected by a timber and plank frame with wooden screens. In the middle of the inside chamber a strong frame of wood and plank will be placed and let into the side walls and made water-tight. In this frame will be inserted three cast iron gates of the same size, and provided with iron frames the same as those in the front wall. There will also be a frame with a fine wire cloth screen placed above the gate frame.

The face of the wall through which the iron pipes pass into the gate house will be made smooth, so as to allow a wooden gate to be put down in the water and close up each pipe. These three pipes will be separated in the gate house by two vertical wooden partitions. The third or waste pipe will be arranged by means of a floor above to discharge the waste water only into the partition attached to the waste pipe. All of the gates will be provided with the proper apparatus to raise them and to discharge the supply water into each, or to shut it off from each. The lower gate well will be 8 by 6 feet and 8 feet deep, covered with trap doors. Each of the pipes will have a stop gate, and the waste gate a curved iron pipe to the discharge culvert. The pipes will be of cast iron of 2 feet interior diameter, and 1½ inches thickness of metal connected by leaded joints. Where the pipes pass through the cut off wall and at the gate house, there will be placed an exterior flange of 42 inches exterior diameter, which is to be leaded to the exterior of the pipe.

TESTS OF AMERICAN IRON AND STEEL.

The following is from an Act of Congress, approved July 25th last: "making appropriations for Sundry Civil Expenses of the Government, for the year ending June 30, 1877."

"For completing experiments in testing iron, steel and other metals, as provided in Section 4, of the Act approved March 3, 1875, $19 396.98; and the Board for Testing Iron and Steel provided for in said section shall be discontinued from and after the expenditure of the amount herein appropriated."

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

Algebra, Elements of ——, for Schools and Colleges. Edward Atkins. London. 12mo. *Collins.* 2s. 6d.

Alphabets, Hand-Book of manuscript, missal and ornamental ——, from the Christian Era to the 17th Century, containing 155 examples. London. oblong. illus. (*New York. Van Nostrand.*) $1.50.

Andes and the Amazon; or, across the Continent of South America. James Orton. 3d ed. rev. and enl., containing Notes of a second Journey across the Continent from Para to Lima and Lake Titicaca. New York. 8vo, illus. *Harpers.* $3.00.

Architecture: containing Designs and Ground Plans for Villas, Cottages, and other Edifices, both suburban and rural. M. Hobbs. 2d ed. Philadelphia. 8vo, illus. engravings. rev. and enl. *Lippincott.* $3.00.

—— Examples illustrating the various Styles and Orders of—with Details of Construction. William R. Ware, Boston. 4to. sheets. *Prang & Co.* (Announcement.)

——, illustrated Papers on Church ——. E. Sharp. London. 4to, illus. *Spons.* (*New York.*) 7s. 6d.

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Ratings, embracing the Book, Stationery and Paper Trades, importing, manufacturing, wholesale and retail, in the United States. New York. 4to. *Merc. & Statis. Agency Assoc.* $30.00.

Botany. Flora of British India. Dr. Hooker. Part IV. London. 8vo, illus. *Reeve.* 10s. 6d.

—— practical, structural and systematic. The latter Portion being an analytical Key to the wild-flowering Plants, Trees, Shrubs, ordinary Herbs, Sedges and Grasses of the Northern and Middle United States east of the Mississippi. August Koehler. New York. 8vo, illus. *Holt.* $3.00.

Bridges. Toll Bridges on River Thames. Parliamentary Report of Committee, with Evidence. London. 8vo. 1s. 1d.

Building, a Book on ——, civil and ecclesiastical; with the Theory of Domes and of the great Pyramid, together with a Catalogue of Sizes of Churches and other large Buildings. Edmund Beckett. London. 8vo, illus. *Crosby, Lockwood & Co.* (Announcement.)

——— Construction, Examples for the Practical Study of—a series of working Drawings in 4 Parts, 12 Plates each, illustrating the various Details in the Construction of a House, with Alternatives for a Building of Wood, Brick, Stone, &c. William R. Ware. Boston. 4to. sheets. *Prang & Co.* $15.00

——— Construction: showing the Employment of Brickwork and Masonry in the practical Construction of Buildings. Vol. I. Text. (Advanced Science Series.) R. Scott Burn. London. 8vo. *Collins.* 2s. 6d.

Canal, the Suez ——. Letters and Documents descriptive of its Rise and Progress in 1854-56. Ferdinand de Lesseps, trans. by N. D'Anvers. 8vo. (*New York. Van Nostrand.*) $5.25.

Carlingford Lough and Greenore. James Barton, with Abstract of Discussion. (Minutes of Proceedings, Institution of Civil Engineers.) London, 8vo. illus. *Ins. Civil Eng.*

Chemistry. The Life Work of Liebig in experimental and philosophic Chemistry; being the Faraday Lecture for 1875. A. W. Hofmann. London. 8vo, portrait. *Macmillan.* (*New York.*) $2.50.

Civil Engineers, Minutes of the Proceedings of the Institution of —— —— with other selected and abstracted Papers. Ed. by James Forrest. Vol. XLIII. Session 1875-6. Part I. London. 8vo, illus. *Inst. Civil Eng.*

Coal Mining. Mining Engineering, a Practical Treatise on —— ——. G. G. Andre. Vol. 2. (completing the work.) London. 4to. illus. *Spons.* (*New York.* Announcement)

Commerce. 18th Annual Report of the Corporation of the Chamber of — of the State of New York, for 1875-6. Comp. by George Wilson. New York. 8vo. *Cham. of Commerce.*

Cyclopædia, the American—a popular Dictionary of general Knowledge. Ed. by George Ripley and Charles A. Dana. Vol. XVI. Trombone-Zymosis. New York. 8vo. illus. *Appleton.* $5.50.

Dictionary of Science and technical Terms used in Philosophy, Literature, Professions, Commerce, Arts and Trades. W. Buchanan. New ed., with Supplement by James A. Smith. London. 8vo. *Tegg.* 6s.

Drawing, a system of elementary ——, with Illustrations and Examples. W. H. Cubley. London. Folio. *Chapman & Hall.* 8s.

—— Examples illustrating the Method of Drawing with Crayon. Mary Carter. Boston. 4to, sheets. *Prang & Co.* (Announcement.)

—— Illustrating the elementary Principles of isometric Projections, Carpentry and Machinery, for use of Mechanics in drawing Schools. James E. Stone. Boston. Folio plates. *Prang & Co.* $6.00.

—— —— for advanced Study in Machinery Drawing. Otto Fuchs. Boston. 4to. sheets. *Prang & Co.* (Announcement.)

Electrical Diagrams and Connections, Handbook of—. Charles H. Davis and Frank B. Rae. New York. 8vo, illus. (*Van Nostrand.*) $1.50.

Engineer's practical Guide for fixing hot Water Apparatus, and warming Greenhouses and Buildings; also Ventilation, Warm Baths, Boilers, &c., &c. John Eldridge. London. 12mo, illus. (*New York. Van Nostrand.*) $0.40.

Engineering Papers, Abstracts of—in foreign Transactions and Periodicals. Ed. by James Forrest. (Minutes of Proceedings, Institution of Civil Engineers. Vol. XLIII., Part I.) London 8vo. *Inst. Civil Eng.*

—— Scientific, read before the Pi Eta Scientific Society, 1876. Rensselaer Polytechnic Institute. Troy. 8vo. illus. *The Society.*

Explorations across the great Basin of Territory of Utah for a direct Wagon Road from Camp Floyd to Genoa in 1859, a Report by J. H. Simpson. (Engineer Department U.S.A.) Washington. 4to illus. *Gov. Printing Office.*

Exploring Expedition, Report of— — from Santa Fé, New Mexico, to Junction of Grand and Green Rivers of the Great Colorado of the West. T. N. Macomb; with geological Report, by J. S. Newberry. Washington. 4to. *Gov. Printing Office.*

Formulæ, Rules and Memoranda for Architects and Surveyors, Handbook of—J. T. Hurst. 10th ed., rev. and re-written. London. *Spons.* (*New York.* Announcement.)

Furnishing, the Art of ——, on national and esthetic Principles. H. J. C. 12mo, illus. (*New York. Van Nostrand.*) $1.75.

Gas. On Estimating the illuminating Power of Coal Gas. William Sugg, with Abstract of Discussion. (Minutes of Proceedings, Institution of Civil Engineers.) London. 8vo. *Inst. Civil Eng.*

——— Purification, Paterson's Patent. Correspondence. Parliamentary Report. London. 8vo. 3d.

Heat, a practical Treatise on —. Thomas Box. rev. and imp. ed. London. *Spons.* (*New York.* Announcement.)

———, Treatise on the mechanical Theory of ——, and its Applications to the Steam-Engine, etc. R. S. McCulloch. New York. 8vo *Van Nostrand.* $3.50.

Holyhead new Harbor. Harrison Hayter; with Abstract of Discussion. (Minutes of Proceedings, Institution of Civil Engineers.) London. 8vo. *Inst. Civil Eng.*

Hydraulic Experiments at Roorkee, 1874-5. Allan Cunningham. Roorkee. 8vo. (*New York. Van Nostrand.*) $6.00.

Ignitions, Theory of simultaneous—read before the Essayons Club of the Corps of Engineers. Henry L. Abbott. (XXIX, printed Papers.) Willet's Point. 4to. illus. *Battallion Press.*

Industries, East London—. W. C. Crory. London. 8vo. *Longmans.* 5s.

Iron Trade in Sweden, present State of—J. Akerman. London. *Spons.* (*New York.* Announcement.)

Lagoons on the South East Coast of Ireland. George H. Kinahan. (Minutes of Proceedings, Institution of Civil Engineers.) London. 8vo. illus. *Inst. Civil Eng.*

Landscape Art: English — its Position and Prospects. Alfred Dawson. London. 8vo. *Whittingham & Wilkins.* 1s.

Levelling, the probable Errors of—with Rules for the Treatment of accumulated Errors. William Airy; with Abstract of Discussion. (Minutes of Proceedings. Institution of Civil Engineers.) London. 8vo. illus. *Inst. Civil Eng.*

Life Assurer's Handbook and Key to Life Assurance. George Clifford. London. 8vo. *Wilson.* 5s.

Light and Photography. Chemistry of —— ——, in their Application to Art, Science and Industry. Herman Vogel. New and rev. ed. (International Scientific Series.) London. 8vo. illus. *Henry S. King.* 5s.

Logic, with Illustrations. W. Stanley Jevons. (Science Primers.) London. 18mo. *Macmillan.* (*New York.*) $0.50.

Machinery, Kinematics of ——: Outlines of a Theory of Machines. F. Reuleaux. Trans. and ed. by A. B. W. Kennedy. London. 8vo, illus. *Macmillan.* (*New York.*) $7.50.

———, a Manual of ——, and Millwork. W. J. Rankin. London. 18mo, illus. *Griffin.* 12s. 6d.

Machinist, the complete practical—embracing Lathe-work, Vice-work, Drills and Drilling, Taps and Dies, Hardening and Tempering, the Use of Tools, &c. Joshua Rose, Philadelphia. 12mo. illus. *H. C. Baird & Co.* $2.50.

Metals, Fatigue of —— under repeated Strains with various Tables of Results of Experiments. Ludwing Spangenberg. Preface by S. H. Shreve. New York. 18mo. *Van Nostrand.* $0.50.

Mind, the Physiology of ——, being the first Part of a 3d ed., enl. rev. and rewritten, of the Physiology and Pathology of Mind. Henry Maudsley. London. 8vo. *Macmillan.* (*New York.*) 10s. 6d.

Mines. Report of Inspectors for 1875. Parliamentary Report. London. 8vo. 10s.

Money of all Nations equalized, and Currency Rates of Sterling Exchange. D. William Diggs. New York. 16mo. *Diggs.* $1.00.

Moon (the) and the Condition and Configuration of its Surface. Edmund Nelson. London. 8vo. illus, *Longmans.*

——— and the Earth. T. Mellard Reade. London. 8vo, illus. *Hardwicke & Bogue.* 1s.

Nautical Almanac, 1877. London. 8vo. *Murray.* 2s. 6d.

Naval Science. Vol. 4. 1875. London 8vo, illus. *Lockwood.* 10s. 6d.

Ordinance Survey. Parliamentary Report for 1875. London. 8vo. 3s. 6d.

Ornamentation, transitional Period of ——: 1145-1150. No. 2, part II. London. *Spons.* (*New York.*) 10s. 6d.

Photography; the Principles and Practice of —— familiarly explained; being a Manual for Beginners. Jabez Hughes. 11th ed., rev. London. 12mo, illus. *Simpkin.* 1s.

Political Economy, Science of ——. Essays and Reviews. Kirklos Lesponts. London. 8vo. *W. Ridgway.* 3s. 6d.

Railways. Return of Accidents, Jan. to March, 1876. Parliamentary Report. London. 8vo. 1s.

——— Inspector's Reports. Part I, Jan. to Feb. Part 2, Jan., Feb., March. Parliamentary Reports. London. 8vo. Each 1s. 3d.

Rainfall, British ——. 1875. On the Distribution of Rain over the British Isles during 1875, as observed at about 1 800 Stations in Great Britain and Ireland. G. J. Simons. London. 8vo, illus. *Stanford.* 5s.

Rules and Tables relating to Mensuration, Engineering, Structures, and Machines. W. J. Rankine. 5th ed., rev. by Edward F. Bamber. London. 12vo, illus. *Griffin.* 9s.

Sanitary Work in the smaller Towns and in Villages. Comprising:—1. Some of the more common Forms of Nuisance and their Remedies; 2. Drainage; 3. Water Supply. Charles Slagg. London. 8vo, illus. *Crosby, Lockwood & Co.* 5s.

——— Engineering. J. Bailey Denton. London. *Spons.* (*New York.* Announcement.)

Science and Art. The Museum of ——. Ed. by Dionysius Lardner. New ed., in 6 vols. London. 8vo. illus. *Crosby, Lockwood & Co.* 22s.

——— Lectures delivered in Manchester, 1875. 7th series. Manchester. 12mo. *Heywood.* (*London. Simpkin.*) 10d.

Sewerage in Paris and Berlin. Report on— trans. by R. Manning. London. *Spons.* (*New York.* Announcement.)

Social Dynamics. System of Positive Polity. Ch. Comte. Vol. 3. Containing Social Dynamics, or the general Theory of Human Progress. London. 8vo. *Longmans.* 21s.

Statics, graphic—. M. Otto, trans. by G. S. Clarke. London. *Spons.* (*New York.* Announcement.)

Steam Engineering, new Treatise on physical Properties of permanent Gases, and of different Kinds of permanent Gases. John W. Nystrom. Philadelphia. 8vo. *Lippincott.* $2.50.

Steam Engines, a practical Treatise on— Arthur Rigg. London. *Spons.* (*New York.* Announcement.)

Steel. Remarks on the Manufacture of—and Mode of Working It. D. Chernoff, trans. from Russian by W. Anderson. London. 8vo. illus. *Clowes & Sons.*

Telegraph Engineers, Journal of the Society of— — No. 12. London. *Spons.* (*New York.* Announcement.)

Telegraphy, Electro—an Introduction to— —. London. *Spons.* (*New York.* Announcement.)

Trade Marks, a Treatise on the Law of —— ——, with the Trades Mark Registration Act of 1875, and the Lord Chancellor's Rules. F. M. Adams. London. 8vo. *Butterworths.* 7s. 6d.

Tunnels, the Ventilation and Working of Railway —— Gabriel J. Morrison; with Abstract of the Discussion. (Minutes of Proceedings. Institution of Civil Engineers.) London. 8vo. illus. *Inst. Civil Eng.*

Vertebrates, a Manual of the ——, of the northern United States, including the District east of the Mississippi River and north of North Carolina and Tennessee, exclusive of marine Species. David S. Jordan. Cincinnati. 12mo, illus. *Jansen, McC. & Co.*

Viaduct, the Verrugas—compared with other Viaducts. Ernest Pontzen; trans. from the German. New York. 12mo. illus. *Railroad Gazette.* $0.50.

Vivisection; the Royal Society for the Prevention of Cruelty to Animals and the Royal Commission. London. 8vo. *Smith & Elder.* 3s. 6d.

Water Supply of Cities and Towns, a comprehensive Treatise on the ——. William

Humber. London. 4to, illus. *Crosby, Lockwood & Co.* (*New York. Van Nostrand.*) $60.00.

—— —— of London: an Essay, exposing the Foulness of the present Supply by the Water Companies, the serious Defects and Consequences of the Systems, and the various Remedies proposed by Engineers and Others. Humphrey D. Sandwith. London. 8vo. *Deacon.* 2s. 6d.

—— Wheels, a Treatise on. W. Donaldson. London. *Spons.* (*New York.* Announcement.)

Yacht Designing: a Treatise on the practical Application of the scientific Principles upon which is based the Art of designing Yachts. Dixon Kemp. London, folio illus. *Field Office.* 63s.

Zoological Record for 1874. London. 8vo. *Van Voorst.* 30s.

ADDITIONS TO

LIBRARY AND MUSEUM.

NOTE: "Copies for distribution" named in this list will, in order of receipt, be sent to members who apply, until the supply is exhausted.

DONATIONS ARE ACKNOWLEDGED AS FOLLOWS:

From W. H. Burr, Troy, N. Y.;

Papers read before the Pi Eta Scientific Society, 1876. Polytechnic Institute, Troy.

From Chamber of Commerce, New York:

Annual Report of Chamber of Commerce for 1875–6, two Parts. New York.

From Department of Civil Engineers of Argentine Republic, Buenos Ayres:

Memorial of Director General of Department of Civil Engineers for 1875. Buenos Ayres (Spanish).

From the Editors and Publishers, New York:

The American Cyclopedia. Vol. XVI. Trombone—Zymosis. New York and London, 1876.

From Charles D. Elliot, Somerville, Mass.

Report on Improvement of Boston Harbor. (Copies for distribution.)

Second Annual Report of City Engineer of Somerville, for 1875. Boston.

From Essayons Club, Willetts Point, N. Y.:

Theory of simultaneous Ignitions. Paper read before the Club, April 3, 1876, by Gen. Henry L. Abbot.

From Gen. A. A. Humphreys, Chief of Engineers, U. S. A., Washington.

Letters from Secretary of War as follows:—

Concerning the Engineer Corps, where stationed, the public Works upon which they are engaged, &c.;

Relating to Increase of Appropriation for Construction of a Snag Boat for Use on the western Rivers;

Transmitting Report of Cyrus B. Comstock on South Pass Improvement of Mouth of Mississippi. (Copies for distribution); and

Report of S. T. Albert on Survey of a Line to connect Cape Fear and Neuse Rivers, and Norfolk Harbor and Cape Fear River.

Reports as follows:—

Exploring Expedition from Santa Fe to the Junction of Grand and Green Rivers of Great Colorado of the West in 1859.

Explorations across Great Basin of Utah for a direct Wagon Route from Camp Floyd to Genoa in Carson Valley, in 1859.

From Institution of Civil Engineers, London, England:

Excerpts from Minutes of Proceedings, Session 1875–6, Part I, as follows:

Abstracts of Papers in Foreign Transactions and Periodicals.

Carlingford Lough and Greenore. James Barton, with Abstract of Discussion.

Estimating the illuminating Power of Coal Gas. William Sugg, with Abstract of Discussion.

Holyhead New Harbour, Harrison Hayter, with Abstract of Discussion.

Lagoons on South-east Coast of Ireland. George H. Kinahan.

Probable Errors of Levelling: with Rules for Treatment of accumulated Errors. Wilfred Airy, with Abstract of Discussion.

Ventilation and Working of Railway Tunnels. Gabriel J. Morrison, with Abstract of Discussion.

List of Members of the Institution, March 25 and June 24, 1876. (2 copies.)

Minutes of Proceedings, General Index, Vols. XXI to XXX. London. 1871.

Minutes of Proceedings, with other selected and abstracted Papers. Vol. XLIII. Session 1875–6. Part I. London, 1876.

From E. P. North, New York:

Reports of Explorations and Surveys for a Railroad from Mississippi River to Pacific Ocean, in 1853–6. Vol. 11. Washington, 1861.

From Clinton B. Sears, Boston, Mass.:

5 Photographs illustrating Breakwater at Wilmington, Cal.

From Miscellaneous Sources:

Appalachia, June, 1876. Boston.

Investigation by Committee on Naval Affairs. Testimony and Documents.

Remarks on the Manufacture of Steel, and the Mode of Working it. D. Chernoff. Excerpts Russian Technical Society. London, 1876.

Report of Hartford Steam Boiler Inspection & Insurance Co., December 31, 1875. Hartford. (2 copies.)

Report of Sheffield Scientific School of Yale College, 1875–76. New Haven.

Seat of Empire. Charles C. Coffin. Boston, 1870.

The Atlantic to the Pacific. What to see and how to see it. John E. Lester. Boston. 1873.

ANNOUNCEMENTS.

MEETINGS.—No regular or stated meetings of the Society will be held from July 5th, to September 6th.

A PAPER HAS BEEN RECEIVED as follows:—

Principles of Tidal Harbor Improvement, as applied at Wilmington, Cal. Clinton B. Sears. July 27, 1876.

PAPERS FOR THE NORMAN MEDAL should be presented before September 1st next. The conditions of award are set forth in the Code of Rules heretofore published in the Journal; a copy will be furnished to applicants.

INDEX TO VOLUME I, PROCEEDINGS, comprising issues from November, 1873, to December, 1875, is issued herewith. More time was required for its preparation than was expected, or it would have been ready earlier.

THE ROOMS OF THE SOCIETY are on the south-east corner of Broadway and Twenty-third street, nearly opposite Fifth Avenue Hotel, and overlooking Madison square; entrance, 4 East Twenty-third street. Members—particularly those from out of town—are invited to make these rooms their head-quarters. Appointments with other parties may be kept here, and for such and similar personal matters a private room may be had.

LIST OF MEMBERS.

ADDITIONS.

COPPEE, HENRY [J.]....As't Eng. Penn. R. R., Philadelphia, Pa.....July 27, 1876.

COTTON, JOSEPH P.....As't U. S. Civil Eng., Newport, R. I.. " 7, "

CRANDALL, CHAS. L. [J.] As't Prof. Eng. Dept., Cornell University, Ithaca, N. Y..... " " "

JOHNSON, J. HOWARD....Res. Eng. Juliaca & Cuzgo R'y, Mollendo, Peru..... " 27, "

SMITH, C. VANDERWORT..Ch'f Eng. Manhattan Gas-Light Co., New York..... " 19, "

CHANGES AND CORRECTIONS.

CHRISTIE, JAMES.....(Care Pencoyd Iron Works), 265 South 4th St., Philadelphia, Pa.

CLAY, GEORGE E.....As't Eng. Improvement Commission, P. O. Box 189, Long Island City, N. Y.

CURTIS, RUSSELL H.....(Care Osborn & Curtis), Rock Island, Ills.

DU BOIS, AUGUSTUS, J....Box 989, New Haven, Conn.

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OSGOOD, JOSEPH, O.....54 India Square, Boston, Mass.

STAUFFER, DAVID M.....Lancaster City, Pa.

American Society of Civil Engineers.

PROCEEDINGS.

Vol. II, August, 1876.

MINUTES OF MEETINGS.

(Abstract of such as may be of general interest to members.)

OF THE BOARD OF DIRECTION.

AUGUST 2D, 1876.—A stated meeting was held at 3 o'clock P. M. : proposals for admission to the Society were considered and other routine business done.

NOTES AND MEMORANDA.

SKETCHES OF ENGINEERING EXHIBITS AT THE INTERNATIONAL EXPOSITION.

In accordance with the plan adopted at the organization of the Centennial Commission of the Society,* the Resident Secretary of the Commission will present a series of sketches, describing the various engineering exhibits at the Exposition, prepared by Members of the Society, who are assisting him in this matter. Such will be of service to those who desire information in regard to the representation at Philadelphia of engineering progress here and abroad.

* Page 3.

THE ENGINEERING EXHIBITS OF SWITZERLAND.

Switzerland, with its peculiar geographical features, its lofty mountains and their extensive ramifications, its rapid streams, its glaciers and lakes, is a country in which we might expect a development of engineering science, especially as it is well populated and requires extensive means of transportation. We find in fact that its engineers give evidence of both scientific and practical culture.

They have sent to the Exhibition, descriptions of some of their principal works and the results of their experience, compiled in so convenient a form that much valuable information may be gathered in a comparatively short time.

Of these works, the Gothard tunnel, as being of much interest to engineers, as well as of great importance to the commerce across the Alps, is represented very thoroughly.

Attention is first drawn to several large profiles and topographical ground plans of the Gothard R. R., including the tunnel, on a scale of 1 to 10 000 or 833 feet to one inch. They comprise the whole road from Flüelen to Biasca. One shows the sections of open roads, bridges, tunnels and snow sheds ; another the corresponding heights of the highway, the Gothard R. R., and the bottom of the valley ; still another represents a geological section of the line including the supposed formations of that part of the mountain still unpenetrated.

There is also a large working profile from Immensee to Balerna for a length of 200 kilo-

meters (124½ miles), from which we may study the gradients; 25 to 1 000 (132 feet per mile) appears a maximum on tangents, in the great tunnel the heaviest grade is 5.82 to 1 000 (30.73 feet per mile).

The contract for this immense undertaking was awarded to Mr. Favre in 1872. The total length of the tunnel, which is entirely on a straight line, is 9.4 miles. The northern entrance at Geschenen is 3 700 feet above the level of the sea, and that of the southern at Airolo is 3 850 feet; the highest point in the interior is intended to be 3 873 feet. The section adopted is the same as that of the Mont Cenis Tunnel, viz., 26 feet 2 inches wide and 19 feet 8½ inches high.

The time allowed for completing the work is 8 years from October 1st, 1872, the estimated cost being $37 000 000. The contractor will receive a premium of $1 000 per day for opening the tunnel before the appointed time, and will be subject to a fine of $1 000 for every day exceeding the same. The average daily number of men employed has been about 1 000, and there are 16 perforators in operation at the present time. These are worked by air, compressed into large vessels by means of water power and conveyed to the boring machinery on trucks.

On the north end, perforators of Dubois & Francais were used up to May, 1874, after which date they were replaced by those of Ferroux, which are of a better construction and require less repairing. The greatest length bored by 6 machines in one month of 1874, was 2 211 meters, each hole averaging 1.1 meter in length. At the south end the perforators used were of Dubois & Francais, McKean and Ferroux. The greatest length bored by 7 machines in one month of 1874 was 2 091 meters, the holes being 1.2 metres in length.

The average daily progress during 1874 was, at the southern end over 2 metres, and at the northern end over 2.5 metres. The maximum daily progress was 6 metres. The total length of tunnel driven up to January 1st, 1876, was 5 410 metres, leaving 9 510 metres yet to be finished.

A complete geological record is kept and here exhibited, of the strata met with during the tunnelling operations, including sets of specimens and a register of the daily meteorological observations. A small collection of these specimens are in a glass case, each one having marked upon it the distance at which it was found from the entrances at Geschenen and Airolo. They consist mostly of mica schist and gneiss, which are the prevailing rocks in this mountain. Upon the case are some fine crystals of quartz found in the tunnel.

Perhaps the most instructive part of this exhibit is a complete set of working drawings. There are twelve different sections corresponding to different classes of materials met with, from solid rock to unreliable strata requiring a heavy lining. The drainage of the rock behind the artificial arch work seems simple, yet thorough, and its importance is fully appreciated. There is also a plan and profile, showing in detail the manner of proceeding with the tunnelling, giving the distances of the various gangs from each other, the places for the machinery tracks, recesses for protection from the effects of blasts, turnouts, and, in short, everything necessary to establish a systematic and economic method of working. We find likewise detailed drawings of the perforators, pumping machinery and apparently all that is requisite to a comprehension of the whole operation. Lastly, there is a set of yearly reports in German and French, and of Quarterly Reports in French alone, which are admirable publications, and furnish perhaps the best and most complete information that can be had upon this the largest and most difficult work of tunnelling ever undertaken.

Another item of interest are the exhibits of the *Nord-ost-balin*, or the Northeastern Railway, one of the most extensive of Switzerland, which present an admirable exposition of the system followed in the construction of the branches connected therewith.

The first is a topographical plan and profile, which may be described as follows :—

When a new road is projected, it is first plotted on one of the excellent maps of Switzerland (scale 1 to 25 000), showing actual contour lines over the whole country, and the general directions and elevations are determined thereon. For establishing the definite alignment, a detailed survey of a narrow strip of country along the projected route is then made according to this method, which is claimed to be specifically Lever's, having been applied there as early as 1838, and is unquestionably very rapid and sufficiently accurate for all practical purposes.

A system of benches or stations is carefully fixed by leveling along the whole route, after which the intermediate topography is surveyed by means of the plane table, talemeter and logarithmic slide rule. From any one station, the position of every visible point may be ascertained by one sight, and immediately plotted as to its direction, distance and elevation. The whole manipulation would simply be: (*a*), sighting and reading the rod held at the required point; (*b*), reading the vertical angle on the alidade; (*c*), calculating the distance and elevation by a simple process

on the side rule; (*d*), plotting the distance and direction on the plane table and noting the elevation.

A constant check on the work is had from the original system of benches and occasional triangulations. The contour lines are at once interpolated between the points by estimation, to show the shape of the ground more truly than could be done in the office. The distance that can be relied upon with a telescope magnifying 20 times, is 400 meters or one quarter mile and the accuracy is within 0.1 per cent. The rapidity with which a survey can be made in this way is very satisfactory. A practiced engineer with two rodmen is able to determine and plot 60 points in one hour or to make a survey of about a square kilometre of a pretty rough country in three working days, *i. e.*, about 80 acres in one day. The scale of these surveys is 1 to 5 000 (416 feet to 1 inch) with contour lines every 2 metres. One of these plane table sheets is exhibited and it compares favorably with our own Coast Survey sheets made in a somewhat similar manner.

Various alignments are now drawn upon these plans, and profiles are plotted by means of a graduated triangle upon cross section paper, a method which is also a very rapid one and facilitates the comparison of the alignments. Estimates of costs are made by means of Culmann's method of "*Massennivellement*" (an ingenious graphical representation of the balance of "cuts" and "fills" for the minimum cost of hauling, depending on distance and grade). In this way the centre line and grade of the railroad is determined, and can be stated at once, generally requiring but small if any correction.

The second exhibit is a handsome volume of 82 plates giving the regulations for the construction of the permanent way, drains, small bridges, retaining well, etc. An extensive set of standard cross-sections for various purposes is given, according to width and slope required by different materials. All slopes of earth, as in Europe generally, are protected by planting shrubs and willows or by sowing grass. There is also a set of plans of stone bridges and culverts for all spans from 1 to 10 metres with the standard dimensions and kind of work for each case. Solidity and first class materials are primary requirements, and simplicity of design is preferred to elaborate ornamentation.

Iron bridges of 2 and 3 metres span are built of rolled I beams; from 4 to 10 metres span, of plate girders. Standards for every thing concerning the permanent way down to spikes, are handsomely engraved and described.

The third exhibit contains a tabular statement accompanied by drawings and photographs, of all the larger iron bridges built from 1872 to 1876, giving dimensions, cost, etc. Here may be seen an extensive application of the lattice girder. It seems strange to American engineers that for large spans the lattice and plate girders should be preferred in Europe to those used in this country, which not only require less iron for the same strength but also much less labor for the erection. The reasons are various, often discussed and sometimes rather difficult to understand. Although knowing both systems perfectly, each country still continues to prefer its own. Attached to this exhibit, there is a very instructive record of test loads and deflections of 7 large bridges. From 3 to 6 heavy freight engines were used as a quiescent load and as a moving load with velocities from 20 to 40 miles per hour. Observations of the deflections and horizontal vibrations showed a great uniformity in each case. The former were found to average about $\frac{1}{1400}$ of the span.

The fourth exhibit is a photo-tracing of the Aare Bridge. This method of copying drawings is becoming very popular in Europe and it is surprisingly little used here. Any drawing on moderately heavy paper can be copied. It is placed face downwards upon a sheet of ordinary photographic paper, inserted into a frame and exposed to the light, exactly as a photograph is printed. After being fixed, this copy (which is a negative) is used precisely as the ordinary negative on glass, to print any number of positive copies of the original drawing.

The most general method of reproduction, however, is by "autography." A specially prepared ink is used in making the drawing, which can be directly transferred and fixed upon a lithographic stone, and any number of prints equal to the original can be made therefrom. Most of the drawings exhibited in the Swiss department have been copied in this way.

In addition to the above, there is a portfolio containing specifications for all kinds of work connected with the road, also line drawings and photographs of locomotives, tenders and cars used upon it.

The idea conveyed to one examining these exhibits, is that the *Nord-ast-Bahn* is conducted with admirable skill, system and economy.

The next important exhibit is on hydraulics. A country filled with large perennial mountain streams and numerous lakes and

valleys cannot, even if its inhabitants were less observing than those of Switzerland, be without much experience in mastering and utilizing that indispensable and important element, water. The result of this experience appears in several exhibits, the most important of which is, perhaps, the literature of the scientific investigation of the flow of water, in which the names of Kutter and Ganguillet appear in the first rank. Their object has been to arrive at a formula which would give correct results, for all cases from large rivers down to small artificial canals, with equal precision.

The important American work by Humphreys and Abbot, containing the results of the river measurements on the lower Mississippi during a period of 10 years, furnished them with the data for large rivers with a small fall. Darcy's and Bazin's French work on hydraulic investigations gave them a great number of very reliable observations on the influence of the various degrees of roughness of the wet perimeter, made during 5 years in small artificial canals of very different shape, material, fall, etc. Lastly, their own observations on small streams, with a strong fall, completed the circle of information from which they have deduced their general formulæ; that it is the most general known up to this date, for the law of the motion of water in rivers and canals, can hardly be doubted. In its algebraic form, it is somewhat complicated for practical use, but they have represented it in a graphical manner by which every difficulty immediately disappears and the use of it becomes extremely easy. It is to be hoped that this graphical representation may be preserved here and become generally known to our civil engineers who will find it to be the most reliable and rapid means of obtaining results in the various cases it claims to cover.

Another exhibit of a more practical character is an examination into the water power of Switzerland. It appears that the utilized power at present amounts to about 70 000 H. P., of which 30 000 are obtained by large turbines, and 40 000 by small turbines and water wheels. The Girard system of turbines is most extensively applied. Compared with the population, this would give one horse-power for every 3 to 4 men working in factories. These results not only show a remarkable industry, but also that a good use is being made of the abundance of water. Steam power is rarely applied, and a statement of comparative cost exhibits good reasons for it.

A table shows the distribution of the water power among the various river basins, and a detailed examination into the total available water power of the rivers of Switzerland. This latter is equal to at least 1 500 000 H. P., of which less than 5 per cent. has so far been utilized. Power is frequently transmitted to great distances by means of wire rope. About 3 000 H. P. is carried over 200 yards, and some even half a mile.

The other exhibits pertaining to hydraulics, are mainly, the correction and regulation of the rivers Aare and Eurme, with ground plans showing extent of works, reclaiming lands, etc. Reports and detailed drawings give ample opportunity for a close study.

A very interesting volume is also presented, showing the construction of dams, jetties, weirs, and whatever is generally required to compel water to be of service, and to prevent it from doing damage.

Among the remaining objects in this exhibit, pertaining to civil engineering, are detailed plans, profiles, sections, bridges and estimates of cost exhibited by the Tösst Valley, Central and Jura-Bern Railroads, and also a description with photographs of the Vetliberg Railway with gradients of 1 in 14 or 377 feet to the mile. The latter is interesting because it requires neither a third rail, rack nor rope, but merely sufficient weight upon the driving wheels to overcome the grade.

A portfolio with plans and estimates for a projected railroad across the Lukmaneir may be of interest to many, as also a number of fine photographs of various old wooden bridges, one built in 1457, and another in 1585.

R. HERING.

ENGINEERING EXHIBITS OF THE NETHERLANDS.

Holland, "the country that draws 6 feet of water," as Madame de Stael expresses it, has an exhibit in the Centennial of rare interest to the engineer. As might be expected from the peculiar conformation of the country, drainage-works, canals and bridges have principally occupied the attention of its engineers. For centuries, the Dutch have been stubbornly fighting the waters of the North Sea, with varying success in times past; but by the aid of engineering science, and great human energy and perseverance, they are now undoubtedly masters of the situation, and year by year they are wresting back from the waters the land stolen at different times from previous generations. How all this is done—

what they have already accomplished, and what they yet intend to do—is here illustrated by beautifully made models and drawings, systematically arranged, in the space devoted to the Netherlands in the Main Building.

In describing this exhibit, these famous dykes and canals first demand attention, for they have literally made, and still preserve this country. A large relief model shows us at a glance, the greater part of Holland, with its complicated system of drainage, canals, its lakes, dykes, towns and railways, all accurately located upon it. The relative elevation of land and water is clearly expressed, and the geology of the country indicated by appropriate coloring. A dyke cutting in two a large surface of water, shows another proposed raid on Neptune's domains. On the model is painted a coat-of-arms, ready made for the province "when drained," with this motto: "*Ex undis Sol*," "Land out of the waters;" a bit of rhyme underneath, in quaint English, promises as follows;

"Haarlem Lake is drained
And drained is the Y,
If peace is maintained,
Zuider Zee gets dry."

Close by this are two other relief models, more highly finished, and protected by glass. One is the "ship canal leading from Amsterdam to the sea," and the other the "entrance to the port of Rotterdam." These bits of country in miniature, with their green fields, lakes and canals, towns and villages, teach the looker-on more of the actual condition of the face of this peculiar land, than a library of books and works of study; they speak in a language all must understand and receive deep and lasting impressions. Here is seen a network of canals, large and small, extending in all directions, with the water surface in many of them very considerably above the level of the cultivated fields, and at once can be realized the immense work undertaken and so successfully carried out by the Dutch engineer. These embankments must be carefully constructed, and as carefully and constantly watched, the smallest leak may prove disastrous; but in spite of all precautions some water will seep through, and this and the rainfall must be lifted up again into the canals; the little windmills that everywhere dot the surface of the models, are depended upon for this service.

A map of "Haarlem Lake," and a drawing of one of the large pumping engines, brings us to another signal triumph of engineering skill. This lake once lay between the towns of Haarlem, Leyden and Amsterdam, and covered over 60 000 acres of land; it was formed in the sixteenth century by the merging into one of four smaller lakes by an eruption of the North Sea which at that time overwhelmed many towns and villages, and destroyed thousands of lives. As long ago as 1623 "Leeghwater" or the "dryer-of-waters," as he was called, a prominent Dutch engineer, proposed to reclaim this wasted land, but this was only finally accomplished between the years 1839 and 1852; 40 000 acres of richest soil have thus been added to the productive area of Holland. After the "Het Y" and other outlets had been closed, the lake was drained by three enormous pumping engines, each one capable of delivering 63 tons of water at a single stroke. The estimated quantity of water to be pumped out was 800 000 000 tons, but this was even increased to 1000 000 000 tons; these three engines, by steady work, could empty it in 400 days. One of these engines is constantly at work, even now, lifting out the water due to rainfall, and the leakage from the higher level of the water courses that surround and run over the former lake-bed.

In the relief model of "the entrance to Rotterdam," the sea end of the canal is shown as being protected by jetties. The construction of the jetties is illustrated by models and drawings; the models are miniature "mattresses" properly made, and provided with their anchors, buoys, etc.; the drawings show the mattresses in place, weighted with stone, and forming the jetties, which on the sea slope are protected by large concrete blocks. The mattresses have their upper surfaces divided into a number of square pockets, by driving stout stakes into the mattress proper, and connecting them by interlaced branches; these pockets hold the stone used in sinking, and prevent displacement of this filling material in case of tipping or unequal settlement. Drawings of the railway embankment across the "Schelde" and the "Sloe," further illustrate the use of mattresses; in this case they protect the earthen slope from the action of the water.

A plan of the north coast of Holland shows the amount of land denuded by the sea between the years 1571 and 1875, and likewise the method proposed to stop this encroachment. It seems to be the intention of the Dutch engineers to build extensive and heavy dykes of earth faced with blocks of concrete, and at proper intervals to project piers into the sea at an angle best suited to break the force of the waves and change the direction of prevailing shore currents. According to the plan exhibited, the loss of area must have been great during the years

mentioned, but then they are trifling when compared to the change in the face of other portions of Holland. The Zuider Zee itself, now containing over 1 300 square miles, was of trifling extent, until the year 1247, when, these existing barriers were swept away, and the present waste of waters was formed.

Hanging on the screens near the exhibits just mentioned, are a number of hydrographic charts which deserve special mention from the excellence of their finish, and the evident care taken in their preparation.

As canals form the principal means of internal communication throughout this water-logged country, the construction of locks and lock-gates must have early engaged the attention of its engineers. Two fine models are exhibited of the "Blanken" and the "Alewijn" gates. These are called "lock-gates," but are really "basin-gates," and are used in maintaining a fixed water level in a basin or dock—unaffected by rise and fall of tide, which greatly facilitates the loading of vessels, and enables them to use a shallow harbor, where they would, without something of this kind, ground at low-tide. The "Blanken" Gate, which we will describe, the other only differing in detail, is kept in position when closed, by water pressure alone. This is effected as follows: Each wing of the gate closing the lock is double- -that is, there is an additional wing strongly secured to each half-gate at the heel-post—making them "V" shaped in plan, with an included angle of about 80°. In each of the side walls of the passage, and on the outside or "seaward" side of the gate, is a quarter-circle chamber, into which these compound gates swing, when they open, and thus leave the channel clear. Two sluice-ways are built in each of the side walls, and open into the chamber just described, in that wall of the chamber lying at right angles to the axis of the passage; the other ends of the sluices communicate, the one with the water outside, the other with the water inside the gates. The action of the gate is as follows: when a vessel has entered the basin, say at high tide, the gates are closed by hand; the extra leaves spoken of will now lie in a line with the side walls of the lock, and thus close the mouths of the chambers. The sluice way leading from the chamber to the outside being closed by a wicket, and the one leading to the basin being left open, the water in the chamber will remain at the same level as in the basin, and as the tide falls outside the gates, the higher water-level in the chamber will press the wing closing it outward against its sill, and this wing will act as a lever to keep the gate proper closed. By shutting the "basin" sluice, and opening the outlet sluice to low-water, the water level in the chamber will be lowered, and the excess of pressure being then on the gate wings, the entire gate will swing into the chamber, and open the passage way. This plan can be used for maintaining a high-water or a low-water level in the basin, at pleasure, by properly manipulating the sluice-ways.

In securing foundations, piles are evidently the main reliance of the Dutch; photographs, plans and models all show them as being generally used whenever a stable footing is desired; and in a country where water everywhere prevails it is undoubtedly the best and cheapest method they could adopt. In driving them, not only the most elaborate steam pile drivers are used, but in several of the photographs showing the progress of work on the "Harbor at Harlingen," the crude driver of a century or more ago, is shown, in which the fall of a heavy iron-shod log, without guides, and hoisted by a rope running over a pulley suspended from a rough tripod, does the work, the log being raised by the united exertions of 10 or 15 men, each pulling on one of the many strands into which the toil of the hoisting rope is divided.

The best model here, of the application of piles to engineering structures, is that of the pier in the harbor of Harlingen. This work is very simple in design, but strong and well adapted apparently to its purpose; the piles supporting this pier are thickly studded with broad headed nails, by no means securing them against the ravages of the teredo navalis, if that is what they are intended for, this worm when young being able to enter the smallest crevice. The earth slope at the shore end of this pier is protected from the action of the waves by what seems to be a sheathing or covering of wood, made of piles, hexagonal in shape, and about 6 feet long; these are driven in as closely as possible, at right angles to the slope of the embankment, and in appearance this sheathing is not unlike some of our American wood pavements.

In a beautiful set of drawings finished in oil, Mr. Fijnje illustrates still another and more elaborate method of securing a foundation, that is by the use of compressed air, or the "Plenum Pneumatic Process," as it is called. He does not say when this was used, but his plans embody many good features, and are worthy of study. The basis of his operations is a rectangular caisson of wrought iron, surmounted by and carrying down with it a pier of brick or concrete faced with cut

stone, the principle being the same as that used in the building of the piers of the St. Louis and East River bridges. To enable workmen to enter the caisson, and to send to the surface the material excavated, there are four cylindrical shafts, arranged in pairs, and extending from the roof of the caisson, through the masonry of the pier to the surface of the water, and considerably above it; in fact, each pair of shafts unite at top above the water level in one chamber, apparently about 10 feet in diameter, and about the same in height; the two shafts, extending down to the caisson are about 3 feet in diameter and 6 feet apart from centre to centre. Wrought iron is used throughout. The construction of this upper chamber is somewhat peculiar, and can be described as follows: The two shafts open directly into the bottom of this cylindrical chamber, and the same air pressure will prevail in it that may be found necessary to expel and keep out the water from the caisson; in fact the compressed air passes into this chamber directly from the compressing machinery. Attached to one side of this large cylinder is a smaller cylinder, forming the "air-lock," and provided with its proper doors and inlet and outlet pipes; it is through this smaller chamber that an entrance is effected into the large chamber, and thence through the shafts to the caisson. In addition to the "air-lock" there are two semi-cylindrical "supply-chambers" attached to the outside of the main chamber, arranged opposite to each other and extending the full height of the main chamber. These "supply chambers" have trap-doors on top through which they are filled with concrete material intended for use in the caisson below. Each one has also a trap at the bottom, opening inwards, directly above the shafts, and by opening these lower traps, the contents of the "supply chamber" can be dropped through the shafts into the caisson. The sand, mud, &c., excavated in the caisson is hoisted into the large chamber by means of iron buckets, drawn up by a chain passing over a large wheel, driven by shafting which passes to the outside through a stuffing box. Each end of the chain carries a bucket, so that as a full bucket ascends one shaft, an empty one descends the other. When the material reaches the top of the shaft, it is tilted into an inclined spout, which passes through the sides of the large chamber, and is provided with an inside and an outside trap, so that when it is filled, the inside trap can be closed and the outside one opened, so as to discharge the contents of the spout into a car, and at the same time prevent the escape of compressed air.

The air to be used in the caisson is compressed by a very simple direct acting horizontal air-pump, and through an "accumulator" passes into the large chamber before described. The air-pump is peculiar in arrangement, and the drawing, as made out, does not appear to show all its details; it seems to consist of a long cylinder, which moves horizontally backwards and forwards over a fixed piston-rod, the rod passing through stuffing boxes in the ends of the cylinder; motion is given to the cylinder by a double rack and pinion gearing. This piston-rod is hollow, and has openings into the cylinder, one on each side of the fixed piston-head. The air compressed by the motion of the cylinder in either direction passes through one of these openings into the hollow piston-rod, and is carried thence by pipes attached to the ends of the rod to a box provided with proper valves, alongside the "accumulator," check-valves on top of the cylinder admit fresh air, to one side or the other of the piston-head at each stroke. The "accumulator" will furnish an air pressure equivalent to 20 atmospheres or a pressure of about 300 pounds per square inch; so says the inscription on the drawing. No wood at all is used in building the caisson; it is entirely of wrought iron, and the roof is made up of deep plate girders under the iron skin, which directly supports the concrete pier.

The bridges of Holland, so elaborately and conspicuously displayed by drawings and models, undoubtedly attract more general attention than anything else in the exhibit. Justly holding the place of honor, facing the main aisle, is a magnificent model of one-half of the large span of the famous "Kuilenberg Viaduct," over the river Leck. This model is accurately made to scale, and reproduces every plate and rivet of the original. A mirror, arranged underneath at what would be the water level, not only adds to its effect as a model, but also allows the engineer to better study the arrangement of the floor system and lower chords. This bridge is still the longest span of straight truss in the world, being 515 feet in length. It was finished in 1866, after the designs of Michaelis. Alongside of the model are beautiful colored drawings, showing the entire bridge in plan and elevation. There are eight other spans besides the large one—that is, one of 262 feet, and seven of 187 feet each. The construction of these trusses may be taken as a type of the prevailing style of bridge on the Continent. It is a riveted lattice girder, with an arched top chord made up entirely of wrought iron plates, angle-iron and brackets, all united by a

myriad of rivets. This bridge is a thorough bridge, intended for a single line of rails.

The entire structure looks strange and even clumsy to the eye of the American bridge-builder, accustomed as he is to the straight lines and comparatively light, skeleton-like appearance of the "pin-connection" truss. The broad plates intersecting and lapping each other in all directions, and everywhere tied by rivets, do certainly convey the idea of mass and consequent strength; but they as certainly awaken a suspicion of waste section and material, and an unnecessary amount of time and labor consumed in the erection; to say nothing of the ambiguity of calculating strains and proportioning the respective members. According to the photographs here shown, the amount and the design of the "false works" required in erecting these riveted girders is simply frightful to the American engineer—it is almost equivalent to putting up two bridges, one within the other.

Close by the "Kuilenberg" model and drawings, are plans of the bridges at "Bommel" and over the "Hollandsch Dieps." The first-named has a total length of 2 777 feet, and is made up of three spans of 394, and eight smaller spans of about 167 feet each. All these trusses are of the riveted lattice type, and only differ from each other in having the top chord arched in the large spans and horizontal in the smaller ones. In these drawings, and on several of the photographs, is shown a small moveable iron platform, suspended from the bottom chord, for the purpose, it is presumed, of inspecting the bottom chords and replacing rivets.

The bridge over the "Hollandsch Dieps" is truly a noble structure, with fourteen spans of 328 feet each, all riveted, lattice girders with arched top chord. At one end is a draw span 203 feet long, in design an inverted "bow-string" girder, with a very deep plate draw; the draw revolves on outside bearing wheels. The fixtures at the ends of the draw-span, intended for lifting and freeing it preparatory to turning, are very elaborate and complicated. The drawings show a mass of cog-wheels, eccentric shafting and counter-weights, but their action is not plain. The shore abutments are a combination of cut stone and brick work—a common engineering expedient where stone is so scarce. The piers are of cut stone, but are most probably filled with brick or concrete, as shown in the plans of a number of other bridges here. If the angry look of the waves dashing against these piers are here correctly represented, obtaining foundations for these same piers must have been rather a serious undertaking. A train of short dumpy cars, hauled by a green locomotive, with a very small stack and disproportionately large boiler, add to the picture, but look odd to an eye accustomed to American rolling stock.

Draw-bridges take up quite a large space on the walls of the Netherlands exhibit, but they nearly all follow the same general design, the truss in all cases being an inverted bowstring, sometimes latticed and sometimes made of plates; all of them are riveted structures. The apparatus for lifting, for locking, and for turning the span, is always very complicated in detail and extravagant in cost; but, if machinery can be relied upon, is no doubt effective. The turning is done by hand, by means of a circular rack and pinion, no steam engine being shown in any case. The pivots are in some "outside" and in others "centre-bearing"—that is, in one the weight is carried on a circle of large wheels between the bottom of the drum and the top of the pivot pier; in the other case the weight is carried and revolves on a heavy upright central shaft, with a circle of lighter wheels to prevent tipping. None of the draws have cones or other anti-friction appliances—hard steel surfaces, lubricated, seem to be depended upon entirely. The pivot pier in several is made of brick or concrete within an iron shell.

The draw at "Dordrecht" differs from the others in being a steel lattice girder, riveted, and with the top and bottom chords parallel. This is a "centre-bearing" pivot, the truss resting on the centre shaft by means of a large cast iron bearing plate, secured in the top chord and bolted to a very heavy central casting, which extends to and is connected with the bottom chords. This latter casting surrounds the shaft, which itself is secured to the pier by a third large casting. The end lifting apparatus differs only from the other draws in being still more fearfully and wonderfully designed. Just how all the gear-wheels, shafting, levers, and eccentrics do work, is more than "any fellow can find out," from a mere inspection of the drawings.

"Crane bridges" are represented by a drawing of a neat design used at "Linge," 26 feet 3 inches opening, made of plate and angle iron; and a brass model of a double swinging crane bridge over the "Delfhavensche Schie;" of which no span is given, but it is small; both carry railroads.

Two large portfolios of plans, exhibited by Capt. Nierstrasz, R. E., of Bois le Duc, are very interesting. The collection embraces plans for bridges, bridge piers and abut-

ments, and designs for stations and other railway buildings. The bridge plans are all riveted lattice girders, as before described. The plans for masonry show great attention paid to the cutting and banding of the face courses, with the concrete and brick filling which seems to be universally used by this engineer. The designs for the abutments of several of his bridges are fine architectural efforts, with castellated tops, gothic windows, towers, and statuary—entirely too elaborate to suit the views of American railway directors.

In closing this brief and unsatisfactory description of the engineering exhibit of the Netherlands, it is but just to say that it reflects great credit on those who have it in charge, and on the engineers who furnished the drawings, models, &c., which in finish and beauty are unexcelled by any, and equalled by few.

D. Mc. Stauffer.

SELECTIONS FROM CORRESPONDENCE.

Mr. C. O. Gleim, Corresponding Member, writes from Cologne, June 28th, 1876, respecting :—

Bridges and Bridge Foundations.—A few days ago I sent the second part of my paper on American bridge-building. The third part, which treats of American drawbridges and iron trestleworks, is in the press. In next year's Hanover Journal I intend continuing the subject by giving special descriptions of the most prominent American bridges, for which I have begun collecting the necessary material, and shall be thankful for any assistance in the way of contributions.

There is at present a question before the *Verband Deutscher Architecten & Ingenieur Vereine*, for discussion, for which I should be glad if the interest of members of the American Society of Civil Engineers could be engaged. It refers to the establishment of rules for the proper dimensions in designing bridge-piers. The fact is, that in this country most bridges have absurdly thick piers, for instance the bridges over the Rhine—which is a very peaceable and well-behaving sort of river—have piers of about 22 feet in width ; and in one recently constructed at Wesel they have reached a width of 26 feet. In the first Rhine bridge, that of Cologne, the size of the piers was governed by the towers standing on them by way of architectural decorations; and in the later bridges, some of which have no such architectural considerations for an excuse, the width has simply become traditional.

In designing the piers for our intended new Rhine bridge at Dusseldorf, I was led to narrower piers by a comparison with bridges in other countries ; and the chief engineer has adopted a width of 4 metres or about 14 feet, which is the utmost that we can hope to get passed by the Government inspectors, though for myself I should not hesitate to go down below 3 metres. At the same time, I have raise1 the general question of establishing rules for determining the dimensions of bridge-piers, and had it adopted for discussion in the *Verband*. Such questions, if sufficiently seconded, are annually sent out for discussion in the several societies of the *Verband*, from whom reports are received at the next annual meeting of the delegates. In this way my question is now up for discussion, and I have been put on the committee of the society at this place.*

I have shown that the size of span and consequent weight of superstructure has little influence in fixing the dimensions of the piers, and that these must be governed by the other forces of current, and impact of floating bodies, like ice, vessels and rafts. As no attempt has been made in Germany to reduce these external forces to absolute figures, I shall be glad to show how this has been done by American engineers in fixing a limit for the largest possible impact of floating ice. At the same time, it is proposed to collect information in regard to bridge-piers of unusually narrow width, together with the conditions under which they have been erected, so as to allow comparisons to be drawn in cases of similar conditions of current, ice-drifts and navigation. In this regard, American bridges are especially instructive, and I should like to give a good exhibit of them.

I am only in possession of details of the piers of the bridges at Quincy, Kansas City, Louisville and Buffalo, and will be pleased to have members of the Society furnish some further information, or point out publications where it can be found. Of course it would be especially instructive if some case could be referred to of a bridge-pier having failed from too slender proportions, being carried away by the ice, or knocked down by a raft or vessel.

* I enclose a copy of the wording of the question and preamble, in case it should be found of sufficient interest, though is seems hardly worth the trouble to give a translation, as the argument is intended principally for German engineers.

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The entire structure looks strange and even clumsy to the eye of the American bridge-builder, accustomed as he is to the straight lines and comparatively light, skeleton-like appearance of the "pin-connection" truss. The broad plates intersecting and lapping each other in all directions, and everywhere tied by rivets, do certainly convey the idea of mass and consequent strength; but they as certainly awaken a suspicion of waste section and material, and an unnecessary amount of time and labor consumed in the erection; to say nothing of the ambiguity of calculating strains and proportioning the respective members. According to the photographs here shown, the amount and the design of the "false works" required in erecting these riveted girders is simply frightful to the American engineer—it is almost equivalent to putting up two bridges, one within the other.

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The bridge over the "Hollandsch Dieps" is truly a noble structure, with fourteen spans of 328 feet each, all riveted, lattice girders with arched top chord. At one end is a draw span 208 feet long, in design an inverted "bow-string" girder, with a very deep plate draw; the draw revolves on outside bearing wheels. The fixtures at the ends of the draw-span, intended for lifting and freeing it preparatory to turning, are very elaborate and complicated. The drawings show a mass of cog-wheels, eccentric shafting and counter-weights, but their action is not plain. The shore abutments are a combination of cut stone and brick work—a common engineering expedient where stone is so scarce. The piers are of cut stone, but are most probably filled with brick or concrete, as shown in the plans of a number of other bridges here. If the angry look of the waves dashing against these piers are here correctly represented, obtaining foundations for these same piers must have been rather a serious undertaking. A train of short dumpy cars, hauled by a green locomotive, with a very small stack and disproportionately large boiler, add to the picture, but look odd to an eye accustomed to American rolling stock.

Draw-bridges take up quite a large space on the walls of the Netherlands exhibit, but they nearly all follow the same general design, the truss in all cases being an inverted bowstring, sometimes latticed and sometimes made of plates; all of them are riveted structures. The apparatus for lifting, for locking, and for turning the span, is always very complicated in detail and extravagant in cost; but, if machinery can be relied upon, is no doubt effective. The turning is done by hand, by means of a circular rack and pinion, no steam engine being shown in any case. The pivots are in some "outside" and in others "centre-bearing"—that is, in one the weight is carried on a circle of large wheels between the bottom of the drum and the top of the pivot pier; in the other case the weight is carried and revolves on a heavy upright central shaft, with a circle of lighter wheels to prevent tipping. None of the draws have cones or other anti-friction appliances—hard steel surfaces, lubricated, seem to be depended upon entirely. The pivot pier in several is made of brick or concrete within an iron shell.

The draw at "Dordrecht" differs from the others in being a steel lattice girder, riveted, and with the top and bottom chords parallel. This is a "centre-bearing" pivot, the truss resting on the centre shaft by means of a large cast iron bearing plate, secured in the top chord and bolted to a very heavy central casting, which extends to and is connected with the bottom chords. This latter casting surrounds the shaft, which itself is secured to the pier by a third large casting. The end lifting apparatus differs only from the other draws in being still more fearfully and wonderfully designed. Just how all the gear-wheels, shafting, levers, and eccentrics do work, is more than "any fellow can find out," from a mere inspection of the drawings.

"Crane bridges" are represented by a drawing of a neat design used at "Linge," 26 feet 3 inches opening, made of plate and angle iron; and a brass model of a double swinging crane bridge over the "Delfhavenche Schie;" of which no span is given, but it is small; both carry railroads.

Two large portfolios of plans, exhibited by Capt. Nierstrasz, R. E., of Bois le Duc, are very interesting. The collection embraces plans for bridges, bridge piers and abut-

ments, and designs for stations and other railway buildings. The bridge plans are all riveted lattice girders, as before described. The plans for masonry show great attention paid to the cutting and banding of the face courses, with the concrete and brick filling which seems to be universally used by this engineer. The designs for the abutments of several of his bridges are fine architectural efforts, with castellated tops, gothic windows, towers, and statuary—entirely too elaborate to suit the views of American railway directors.

In closing this brief and unsatisfactory description of the engineering exhibit of the Netherlands, it is but just to say that it reflects great credit on those who have it in charge, and on the engineers who furnished the drawings, models, &c., which in finish and beauty are unexcelled by any, and equalled by few.

D. Mc. Stauffer.

SELECTIONS FROM CORRESPONDENCE.

Mr. C. O. Gleim, Corresponding Member, writes from Cologne, June 28th, 1876, respecting :—

Bridges and Bridge Foundations.—A few days ago I sent the second part of my paper on American bridge-building. The third part, which treats of American drawbridges and iron trestleworks, is in the press. In next year's Hanover Journal I intend continuing the subject by giving special descriptions of the most prominent American bridges, for which I have begun collecting the necessary material, and shall be thankful for any assistance in the way of contributions.

There is at present a question before the *Verband Deutscher Architecten & Ingenieur Vereine*, for discussion, for which I should be glad if the interest of members of the American Society of Civil Engineers could be engaged. It refers to the establishment of rules for the proper dimensions in designing bridge-piers. The fact is, that in this country most bridges have absurdly thick piers, for instance the bridges over the Rhine—which is a very peaceable and well-behaving sort of river—have piers of about 22 feet in width ; and in one recently constructed at Wesel they have reached a width of 26 feet. In the first Rhine bridge, that of Cologne, the size of the piers was governed by the towers standing on them by way of architectural decorations; and in the later bridges, some of which have no such architectural considerations for an excuse, the width has simply become traditional.

In designing the piers for our intended new Rhine bridge at Dusseldorf, I was led to narrower piers by a comparison with bridges in other countries ; and the chief engineer has adopted a width of 4 metres or about 14 feet, which is the utmost that we can hope to get passed by the Government inspectors, though for myself I should not hesitate to go down below 3 metres. At the same time, I have raised the general question of establishing rules for determining the dimensions of bridge-piers, and had it adopted for discussion in the *Verband*. Such questions, if sufficiently seconded, are annually sent out for discussion in the several societies of the *Verband*, from whom reports are received at the next annual meeting of the delegates. In this way my question is now up for discussion, and I have been put on the committee of the society at this place.*

I have shown that the size of span and consequent weight of superstructure has little influence in fixing the dimensions of the piers, and that these must be governed by the other forces of current, and impact of floating bodies, like ice, vessels and rafts. As no attempt has been made in Germany to reduce these external forces to absolute figures, I shall be glad to show how this has been done by American engineers in fixing a limit for the largest possible impact of floating ice. At the same time, it is proposed to collect information in regard to bridge-piers of unusually narrow width, together with the conditions under which they have been erected, so as to allow comparisons to be drawn in cases of similar conditions of current, ice-drifts and navigation. In this regard, American bridges are especially instructive, and I should like to give a good exhibit of them.

I am only in possession of details of the piers of the bridges at Quincy, Kansas City, Louisville and Buffalo, and will be pleased to have members of the Society furnish some further information, or point out publications where it can be found. Of course it would be especially instructive if some case could be referred to of a bridge-pier having failed from too slender proportions, being carried away by the ice, or knocked down by a raft or vessel.

* I enclose a copy of the wording of the question and preamble, in case it should be found of sufficient interest, though is seems hardly worth the trouble to give a translation, as the argument is intended principally for German engineers.

But the question ought to be strictly separated from that of insufficient foundation.

Speaking of bad foundations:—have you heard of the case of the large Elbe bridge at Riesa giving way lately from being underwashed in the foundations? I will write for a photograph showing the bridge after destruction, and soon send it with a short account, as far as I can collect the dates.*

* Members willing to furnish the information desired will please send data to the Secretary.

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

Alphabet, Handbook of illuminated initial Letters from the 6th to the 18th Century, containing 363 Examples; and Manuscript Missal and Monumental Alphabets from the Christian Era to the 17th Century, containing 155 Examples. London. 4to, illus. *Newbury.* 12s.

Bridges, Toll Bridges, River Thames. Index to Report (Parliamentary). London. 8vo. 4d.

Building Construction: showing the Employment of Brickwork and Masonry in the practical Construction of Buildings. R. Scott Burn. Vol. 2. Plates. London. 4to. *Collins.* 5s.

Catalogue, Publishers' Trade-List Annual. New York. 8vo. *Leypoldt.* $1.50.

Civil Engineers, Minutes of the Proceedings of the Institution of — — with other selected and abstracted Papers. Ed. by James Forrest. Vol. XLIV. Session 1875-6. Part III. London. 8vo. illus. *Inst. Civil Eng.*

Coal Mining. Mining Engineering, a practical Treatise on — —. George C. Andre. 2 vol. London. 4to, illus. *Spons* (*New York*). $28.00.

——— Statistics, giving the past and present production of Coal in the United States and abroad. Richard P. Rothwell. (New York. Announcement.) *Sci. Pub. Co.*

Colorist, textile—a monthly Journal of Bleaching, Printing, Dyeing, &c. Ed. by Charles O'Neil. Vol. I. Manchester. 8vo. illus. *Palmer & Howe.* (*New York, Wileys*). 21s.

Design, Manual of —, compiled from Writings and Addresses. Richard Redgrave. (South Kensington Handbooks.) London. 12mo, illus. *Chapman & Hall* (*Van Nostrand, New York*). $1.00.

Dynamics, Principles of —, an elementary Text-book for Science Students. R. Wormell. London. 12mo. *Rivingtons.* 6s.

Electricity and Magnetism, Enquiry into the Nature and Results of—, by Anglicanus. 8vo. London. *Washbourne.* 6s. 6d.

Exhibition. Philadelphia International ——, 1876. Official Catalogue of the British Section. Two parts. London. 4to. 5s.

——— Vienna, 1873, Report of the Commissioners of the United States to the International Exhibition at Vienna, 1873, published under Direction of the Secretary of State. Ed. by Robert H. Thurston. Vol. I. Introduction, Execution, Commission, Agriculture; Vol. II. Science and Education; Vol. III. Engineering; Vol. IV. Architecture, Metallurgy. Washington. 8vo, illus. *Gov. Printing Office.* (*Van Nostrand, New York.*) $15.00.

Geology, historical ——. (Chambers' Science Manuals.) James Geikie. London. *Chambers.* 1s.

Hydraulic Canal Lift at Anderton, on River Weaver. Sydingham Duer. (Minutes of Proceedings, Institution of Civil Engineers.) London. 8vo, illus. *Inst. Civil Eng.*

Iron Manufacture of Sweden, present State of —. R. Akerman. London. 8vo. *Spons,* (*New York*). 4s. 6d.

Light-house, Dhu Heartach—. David Stevenson (Minutes of Proceedings, Institution of Civil Engineers). London. 8vo, illus. *Inst. Civil Eng.*

Manufacturing Industries, British —. Ed. by G. Phillips Bevan. Shipbuilding by Bedford Pim, Telegraphy by Robert Sabine, Agricultural Machinery by Prof. Wrighton, Railways and Tramways by D. Kinner Clark. London. 12mo, illus. *Stanford.* (*Van Nostrand, New York.*) $1.75.

Mechanical Engineers, Proceedings of Institution of —, May 3d, 1876. Nos. 2, 3. Birmingham. 8vo, illus.

Money, Weights and Measures of the chief commercial Traders in the World, with the British Equivalents. W. A. Browne. London. *Stanford.* 1s. 6d.

Navigation and nautical Astronomy, Practice of —. William C. Bergen, 4th ed. London. 8vo. *Simpkin.* 16s.

——— Abridgment of—. London. 8vo. *Simpkin.* 10s.

Plains of the great West, and their Inhabitants. Richard J. Dodge, New York. 8vo, illus. *Putnams.* (Announcement.)

Plumbing; a Text Book to the Practice of the Art or Craft of the Plumber; with supplementary Chapters upon House Drainage, embodying the latest Improvements. William C. Buchan. (Weale's Series.) London. 12mo, illus. *Crosby Lockwood.* 3s.

Pocket-Book of Pocket-Books; being Molesworth and Hurst's Pocket-Books, printed on India Paper and bound together. London, 32mo. *Spons.* (*New York.* Announcement.) 12s. 6d.

Political Economy. Subdivision I. Natural Law of Wages paid for Work to the Amount done (Piecework), when the Employer incurs Charges in respect of the Employment of the Employed. Edward Altingdean. London. 16mo. *Gilbert & Rivingtons.* 5s.

Pottery and Porcelain of the Renaissance and Modern Periods, Marks and Monograms. William Chaffers. 6th ed. re. and aug. London. 8vo, illus. *Bickers.* 42s.

Railroads and Telegraphs of Ohio. Ninth Annual Report of the Commissioners of — for year ending June 30, 1875. Columbus.

——— Manual of —— in the United States for 1876-77; showing their Mileage, Stocks, Bonds, Cost, Traffic, Earnings, Expenses, and Organizations; with a Sketch of their Rise, Progress, Influence, etc.; together

with an Appendix, containing a full Analysis of the Debts of the United States and of the several States. Henry V. Poor. Ninth Series. New York. 8vo. *Poor.* $5.00.

Sanitary Defects in Villages and Country Districts, and how to remedy them. George Wilson. London. 8vo. *Churchill.* 1s. 6d.

———. Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors. Ed. by L. Angell. Vol. 2. London. 8vo. *Spons.* (*New York.*) $3.00.

——— Works abroad, Report of the Commission appointed to propose Measures for remedying the Pollution of the Seine; with a Description of the Works in Course of Execution for the Sewerage of Berlin, and the Application of Sewage to Irrigation at Marienfeldar and Falkenburg. Trans. from the French by Robert Manning. London. 8vo. Maps. *Spons.* (*New York.*) 2s. 3d.

——— Unhealthiness in Houses. William Eassie. New York. *Putnams.* (Announcement.)

Science Papers, chiefly pharmacological and botanical. Daniel Hanbury. Ed. with Memoir, by Joseph Ince. London. 8vo. *Macmillan.* (*New York.*) 14s.

Sewage Utilization, comprising—Sewage Interception Systems, or Dry-Sewage Processes. G. R. Redgrave: Treatment of Sewage by Precipitation, William Shelford. With Abstract of Discussion, (Minutes of Proceedings, Institution of Civil Engineers). London. 8vo. illus. *Inst. Civil Eng.*

Telegraph Department. Report of Committee on the Post Office — — (Parliamentary.) London. 8vo. 6d.

Tree Lifter, a new Method of Transplanting Forest Trees. George Greenwood. 8d. London. 8vo. *Longmans.* 10s. 6d.

ADDITIONS TO

LIBRARY AND MUSEUM.

DONATIONS ARE ACKNOWLEDGED AS FOLLOWS:

From S. T. Albert, Washington:

Report on Survey of a Line to connect Cape Fear and Neuse Rivers, and Norfolk Harbor and Cape Fear River. Maps. Washington. 1876.

From O. Chanute, New York:

Specifications of Long Island Bridge. (Several copies.)

From Department of State, Washington:

Reports of Commissioners of U. S. to International Exhibition at Vienna, 1873. 4 Vols. Washington. (Duplicate.)

From Charles F. Flowers, Columbus, O.:

Ninth Annual Report of Commissioners of Railroads and Telegraphs of Ohio, for year ending June 30, 1875. Columbus.

From John M. Goodwin, Cleveland, O.:

Mercer Iron & Coal Co. Report on Stoneboro' Mine. J. M. Goodwin. Cleveland. 1876.

From Gen. A. A. Humphreys, Chief of Engineers, U. S. A., Washington:

Act making Appropriations for Constructions, Repairs, &c., of certain Public Works on Rivers and Harbors, and for other purposes.

Letters from Secretary of War, as follows: (in duplicate.)

Relating to Clause in River and Harbor Bill, regarding Works at South West Pass of the Mississippi River.

——— to Encroachments of the Sea, upon site of Fort Stevens, Oregon.

——— to Failure of Appropriation for Military Surveys.

——— to Improvements of Brunswick Harbor, Ga.;—and Channel of Entrance to Cumberland Sound.

——— to Improvement of Brunswick Harbor, Ga.

Transmitting Reports of Col. Craighill, on Condition of Aqueduct Bridge at Georgetown;—of Maj. Gillespie, on Improvement of Harbor at Chicago;—of Maj. McFarland on Survey of certain Rivers in Virginia and Tennessee.

From Institution of Civil Engineers, London, England:

Excerpts from Minutes of Proceedings, Session 1875–6, as follows:—

Dhu Heartach Lighthouse. David A. Stevenson.

Hydraulic Canal Lift at Anderton, on the River Weaver, Sydinham Duer.

Sewage Utilization, comprising—Sewage Interception Systems, or Dry Sewage Processes, G. R. Redgrave; Treatment of Sewage by Precipitation, William Shelford; and Discussions.

Minutes of Proceedings, with other selected and abstracted Papers. Vol. XLIV. Sessions 1875–6. Part II. London. 1876.

From Institution of Mechanical Engineers, Birmingham, England:

Proceedings, May 3d and 10th, 1876. Nos. 2, 3. Birmingham.

From Charles Paine, Cleveland, O.:

Griffith's Live Stock Annual, for 1876.

From H. V. & H. W. Poor, New York:

Manual of the Railroads of the United States, 1876–7. New York.

From William H. Twiss, Cortland, N.Y.:

King Iron Bridge and Manufacturing Co. Book of Designs. (Duplicate.)

From Hon. W. C. Whitthorne, Washington;

Testimony and Documents before Committee on Naval Affairs.

From Miscellaneous Sources:

Celebration of the 99th Anniversary of American Independence in Fairmount Park, July 5th, 1875.

Contraction of legal Tender Notes vs. Repudiation and Disloyalty. David A. Wells. New York. 1876.

Publishers' Trade List Annual. New York. 1876.

Speech of W. M. Evarts on Rapid Transit. New York. 1876.

ANNOUNCEMENTS.

MEETINGS.—No regular or stated meetings of the Society will be held from July 5th, to September 6th.

DONATIONS TO THE LIBRARY.—Members and others are asked to contribute regularly to the library of the Society, copies of government, municipal, railway, canal and other reports, specifications, profiles, maps, photographs and like matter, making up the record of engineering operations for the past or present, and to inform the Secretary where such may be had. Duplicate copies are desired, for transmission to foreign societies in return for works collected and sent to this library by them; also for exchange with members and others who wish complete sets referring to particular subjects. In order to gather material now considered but of little value, but of great future importance in the history of the public works of this country and a comparison of their economical results, donations are solicited of old reports or pamphlets, which in any way refer to construction or operation.

PHOTOGRAPHS OF MEMBERS.—By resolution of the Society, each member has been requested to furnish two photographs of himself, of the usual card size, as a means of promoting social recognition and intercourse. Those who have not complied with this request are specially asked to aid in making the collection complete, by speedily forwarding their photographs, endorsed with autograph and date.

THE ROOMS OF THE SOCIETY are on the south-east corner of Broadway and Twenty-third street, nearly opposite Fifth Avenue Hotel, and overlooking Madison square; entrance, 4 East Twenty-third street. Members—particularly those from out of town—are invited to make these rooms their headquarters. Appointments with other parties may be kept here, and for such and similar personal matters a private room may be had.

AS APPENDIX to this number of the Journal, is issued:

Lawrence Water Works. Reports on the Trial of Duty and Capacity of the Pumping Engines. May, 1876; by Messrs. William E. Worthen, J. C. Hoadley and Joseph P. Davis.

LIST OF MEMBERS.

CHANGES AND CORRECTIONS.

BEEBOUT, EDWARD N....Res. Eng. Pennsylvania Co., Canton, O.
BELKNAP, WILLIAM R....113 Main street, Louisville, Ky.
BROWN, ROBERT N.....36 Delaware street, Buffalo, N. Y.
CONSTABLE, CASIMIR.....Sup't Roane Iron Co., Rockwood, Tenn.
FOWLER, CHARLES E.....Box 303, New Haven, Conn.
KENNEDY, WILLIAM H...Lock Box 288, Pittsburgh, Pa.
KIMBALL, GEORGE A.....City Engineer, Somerville, Mass.
MCCLINTOCK, WILLIAM H.146 W. Jefferson street, Louisville, Ky.
MCGEE, JOHN .....Marietta, O.
RICE, EDWARD C.....1506 Washington avenue, St. Louis, Mo.
SEDGWICK, THOMAS S....814 Seventeenth street, Washington, D. C.
SEYMOUR, CHARLES.....Ch. Eng. H. & I. R'y, Madisonville, Ky.
SHERMAN, THOMAS M....154 W. avenue, Rochester, N. Y.
TALCOTT, E. N. KIRK....Joint Principal, Mount Vernon Military Academy, Washington Heights, Cook Co., Ills.
VAN BUREN, JOHN D., Jr..State Engineer and Surveyor, Albany, N. Y.

American Society of Civil Engineers.

PROCEEDINGS.

Vol. II, September, 1876.

MINUTES OF MEETINGS.

(Abstract of such as may be of general interest to members.)

OF THE SOCIETY.

SEPTEMBER 6TH, 1876.—A regular meeting was held at 8 o'clock P. M. The vote on admission to membership was canvassed, and the following were elected: Members—John S. Albert, Henry Cartwright and Henry W. Wilson of Philadelphia, Pa.; William Hood and George S. Mendell of San Francisco, Cal.; Philetus H. Philbrick of Iowa City, Ia. and Edward T. Scovill of Cleveland, O.; and Juniors—Daniel P. Bruner of Harrisburgh, William A. G. Emonts of Philadelphia and D. Jones Lucas of Foxburg, Pa., and John C. Kennedy of Toronto, Can.

A paper by Clinton B. Sears, Engineer Corps, U. S. A.—"Principles of tidal Harbor Improvement as applied at Wilmington, Cal.," was presented, in part read and reading of remainder deferred until the next meeting.

The matter of time and place of the Ninth Annual Convention, was referred to a committee, to ascertain by circular the preferences of members and to report at the Annual Meeting.

Messrs. Paul Panayeff of Moscow, Russia, and Ernest Pontzen* of Vienna, Austria, were introduced, and made brief remarks upon American engineering as observed during their visit to this country.

OF THE BOARD OF DIRECTION.

SEPTEMBER 6TH, 1876.—A stated meeting was held at 3 o'clock, P. M.: proposals for admission to the Society were considered and other routine business done.

* Corresponding Member of the Society.

REPORT OF COMMITTEE

On a Uniform Method of Gauging Streams.

Discussion at the Eighth Annual Convention.

Mr. James R. Croes.—The report made by the committee opens with a misstatement of the object for which the committee was appointed, continues with an expression of opinion on a subject on which there can hardly be any doubt existing, and concludes by a re-statement in other words, of arguments already presented and printed.*

The report terms the committee, one on "The Uniform Gauging of Streams." The resolution † calls for a committee to report on the feasibility of establishing a uniform system of gauging of streams in connection with observations of rain fall. The difference between the two is clear to me, and to all with whom I have conferred on the subject, except the two members of the committee who sign the report, and one of them acknowledged that he had not read the resolution.

The idea that there is any uniform method of gauging, applicable to streams of all sizes and characters, never was entertained by the proposer of the resolution.

The argument for the appointment of the committee, already referred to, concluded with a statement of the qualifications required for members of the committee. The gentlemen appointed were supposed to possess these qualifications in an eminent degree, and it is to be regretted that they have not taken steps to carry out the instructions under which they were appointed.

* Vol. I, page 287. † Vol. I, page 210.

NOTES AND MEMORANDA.

SELECTIONS FROM CORRESPONDENCE.

American Bridge Construction.—Prof. Paul Panayeff, of the Imperial Technical School, Moscow, Russia, now in this country, writes the Secretary substantially as follows:—

The object of the American Society of Civil Engineers—the advancement of engineering in all its branches—is, as I understand it, one quite scientific and practical. Believing this, I respectfully request assistance in a scientific undertaking, the aim of my commission in this country by the Council of the Imperial Technical School of Moscow and the Russian Government.

The recent wonderful progress of American engineering remains almost unknown in Europe, and even its true scientific principles are misunderstood by most of the European professional public. This fact is to be regretted in all respects. It delays the progress of one important art not only in Europe but partly also in this country. Besides this, many engineers and manufacturers here, who could with great ease compete with those of England and Belgium in construction of bridges in Russia and other countries of Europe, which more or less import their bridges, are not at present in position to try the business, because proposals will not be accepted from a country in which engineering is supposed to be conducted in quite an empirical manner.

Such regretful misconception of European professional men arises from the present state of American technical literature; it is quite poor in comparison with that of Europe, which is full of descriptions of all constructions of some interest, with details and drawings on large scale. With a few exceptions, the works of American engineers are not described in such scientific manner, whence the foreign public is led to think that they are directed in an empirical manner and cannot answer the requirements of real art and science. This opinion is so established, that reports of commissioned experts on the progress of American engineering are discredited, particularly because these reports are not accompanied with sufficient data and drawings. The most valuable report of an eminent French engineer, Prof. Malezieux, failed from this same reason, and the persons who, from theoretical points of view, have accepted his conclusions and those

of other commissioned reporters, are accused of an attempt to pervert the public sense with accounts of constructions of a superficial character; because in Europe, as through the whole world, the public knows more of bridges, &c., which have failed than of others which stand and are perfect.

As, in my lectures, I advocate the superiority of American bridges and foundations, the counsel of the Imperial Technical School, and the Government, commissioned me to this country, in order that I might gather information about the state of American engineering in comparison with European. I have already seen and collected sufficient data and drawings to satisfy me, that in advocating the superiority of American bridge work. I have not made a mistake; but such is not sufficient to induce the professional public, influenced by the extensive European literature, to accept my conclusions, particularly as new writers have begun to ballast American literature with compilations from merely analytical and not really theoretical European works. As, in their compilations, the European practice is advocated, the public is led to believe that the original American practice, notwithstanding its large extension, has not given valuable results sufficient to satisfy the speculative mind, and that consequently the European practice, although defective, is most correct theoretically. I (and I am sure, the other engineers, similarly commissioned to this country), are of the contrary opinion; but in order that our views may be accepted by those who have not been in this country or who are not interested in such acceptance, it is necessary to have more materials than I have or can obtain in my short stay here, and therefore I must ask assistance in gathering information. This matter is in direct connection with the advancement of engineering and the true interests which are represented by your Society; the aid thus rendered in gathering information, will at the same time serve the interests of science and engineering art.

I wish to refer to principles and not persons, and for this reason I desire to have data of most of the different kinds and quality of construction; particularly of structures which have failed, for of such, generally, the experience is—for scientific and speculative investigation—more fruitful, than of those which have not failed. To make a true impartial comparison and to arrive at an instructive conclusion concerning different constructions of one class, it is necessary that the data shall be on one scale. With this view, before leaving Moscow, I had sheets of questions relating to bridges and foundations printed, copies of which I hand you. It is desirable to obtain information in reply to each question, which information will be found on the working drawings, or in the notes and specifications. I shall, however, feel obliged for every kind and extent of information relating to this matter. All such will be highly appreciated and fruitful, particularly if accompanied by drawings—preferably to large scale—or even sketches or details, either, with measures written on them, so as to give a good understanding of the peculiarities of construction.

All information gathered in this country, with that obtained in England, France and Germany, will be published in my report (in Russian and English), and I will send copies to them, who favor me with the data and information desired.

NOTE *by the Secretary.* By the two circulars of Prof. Panayeff, (copies of which will be sent upon request, until the supply is exhausted,) information is requested under the following heads.

I.—*Regarding Foundations.*

1°. Kind of building erected in foundation.
2°. Name, locality and date of building.
3°. Name of engineer.
4°. Local conditions.
  A. Depth of water—
    at time of low water;
    at time of freshet. (H. W.)
  B. Velocity of current.
  C. Nature of soil—
    intermediate strata;
    bearing stratum.
5°. System and particulars of foundation.
  A. Method, say principles of constructing foundation and its protection from scour.
  B. Dimensions of foundations.
    a. Number of separate bearing beds, (supports).
    b. Dimensions of one bearing bed, (support.)
      1. Surface, in square feet or meters—
        on bearing stratum;
        above water surface.
      2. The length, (depth);
        in soil;
        from the bed of river up to low water surface;
        above the low water to the base of the superstructure.
6°. Dimensions of superstructure, based on—
  A. Surface in square feet or meters of superstructure, on its base.
  B. The elevation of superstructure in feet or meters, from its base.
7°. Weight and pressure on support.
  A. Weight of superstructure.
  B. The value adopted for the adhesion of the ground, per square foot of surface in contact.
  C. The pressure at the base, per square foot.
8°. Time employed in erection.
  A. Of one bearing bed (support).
  B. Of the whole foundation up to the base of superstructure.

9°. Expense of erection.
  A. Per unit—
    of one square foot or meter of bearing surface;
    of one foot depth in soil.
  B. Of one separate bearing bed, (support).
  C. Of the whole bearing beds, (say total foundation up to the base of superstructure).
10°. Remarks and references.

II.—*Regarding Superstructures.*

1°. Kind and material of bridge.
2°. Name, locality and date of construction.
3°. Name of engineer or builder.
4°. Bridged space.
  A. Number of spans.
  B. Length of span between the centers of support.
  C. Clear span.
  D. Total length crossed by bridge.
5°. Platform or roadway.
  A. Position of platform in relation to main girder.
  B. Net width of platform.
  C. Length of cross beams.
  D. Distance between cross beams.
6°. Girder.
  A. System of girder.
  B. Number of girders.
  C. Dimensions of girder—
    span;
    depth of girder;
    number of panels;
    panel length.
7°. Weight of bridge.
  A. Weight of platform.
  B. Weight of one girder in tons.
    a. Booms—
      top chord;
      bottom chord.
    b. Web or bracing—
      ties;
      struts.
    c. Weight per lineal foot.
    d. Total.
  C. Lateral bracing.
  D. Total weight of the structure in tons.
8°. Data for calculation of strain.
  A. Principles or method of calculation.
  B. Data for live load in tons.
    a. Concentrated load;
      load of each pair of wheels;
      distances of axles.
    b. Uniformly distributed;
      rolling load per foot run.
  C. Values adopted for limited, (working) stress, per square inch in tons.
    a. On wood—
      tension;
      compression.
    b. On cast iron—
      tension;
      compression.
    c. On wrought iron—
      tension;
      compression.
    d. On steel—
      tension;
      compression.
  D. Ratio of ultimate resistance of material to the limited (working) stress, or the factor of safety.
9°. Time employed in erecting the bridge from beginning to end of work.
  A. Time employed in erection of abutments and piers.
  B. Time employed in erection of girders, &c.—
    time employed in workshop;
    time specially employed to connect all parts and to put the whole structure in place;
    total time.
  C. Total time employed in erecting the bridge.
10°. Expenses.
  A. Cost of piers and abutments.
  B. Cost of girders, platform, &c.—
    cost, delivered in pieces;
    cost of putting all parts together;
    cost in finished state, up to opening for traffic.
  C. Total cost.
11°. Remarks and references.

Communications may be addressed to Paul Panayeff, Professor of Civil Engineering, Imperial Technical School, Moscow, either direct, or "Care of the Secretary" here. It is important that such should be forwarded in time to reach him before January 1st.

JETTIES AT SOUTH PASS, MISSISSIPPI RIVER.—George W. R. Bayley writes, September 6th, from Port Eads:

On 4th inst. I was present when soundings over the outer bar between the jetties were made, which showed 21.4 feet as the least depth to *average* high tide, and only *two* soundings of that depth. This would give fully 22 feet depth to *high* tide, and 22½ feet to extraordinary high tide. At Head of Pass the river has fallen 2 feet, and the river current is very slack in consequence; too slack to occasion rapid scour in our nearly completed concentrated channel there. Had our works been as far advanced three or four months ago, at Head of Pass, as they will be two weeks hence, we would now have as much depth there as at the Pass mouth.

COMMITTEE WORK.—Mr. Charles Paine of Cleveland, O., writes:—

* * * I think the smaller the committee, the better the work will be done, and with due respect for the valuable labors of many of our most distinguished members upon committees, I feel bound to say, that the work they have done alone, and unencumbered by associates, is the best and of the most value to the Society.

There are but few subjects in which several persons can feel an equal interest, and the careful study of a subject by one person who is so interested, is of more value than any discussion by an appointed committee, whose members are somewhat indifferent. It seems that this could be clearly shown by comparison of the papers which have proceeded from individuals, self-devoted to their undertakings, with those for which we are indebted to committees appointed by the Society. I do not know how to get this before the Society in the best way; but I would like to make a motion that no committee on any subject shall consist of more than two, preferably of only one.

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

Algebraic Equations, a Treatise on the Theory and Solution of —— —— John Macnie. New York. 8vo. *Van Nostrand.*

Algebra Self-Taught. W. P. Higgs. London. 12mo. (*Van Nostrand. New York.*) $1.50.

Archæology of Rome. John H. Parker. Vol. 2. The Forum Romanum and the Via Sacra. London. 8vo. *Parker.* 15s.

Architectural and historical Sketches, chiefly Italian. Edward A. Freeman. London. 8vo, illus. *Macmillan.* (*New York.*) 10s. 6d.

Architecture. Illustrated Papers on Church —— Edmund Sharpe. No. 2. Cistercian Architecture. Part I. General Plan (continued), with Appendix. London. 4to, illus. *Spons.* (*New York.*) $3.00.

—— Interior —— Doors, Vestibules, Staircases, Ante-rooms, Drawing, Dining and Bed Rooms, Libraries, Bank and Newspaper Offices, Shop Fronts and Interiors, Plans, Sections, Elevators and Details. M. D'Aubourg. Paris. Folio. (*Van Nostrand. New York.*) $8.50.

Art, ecclesiastical —in Germany during the Middle Ages. Wm. Lubke, trans. from the German by L. A. Wheatley. 3d ed., illus. Edinburgh. (*Van Nostrand. New York.*) $5.00.

Beetles, British and foreign, containing a full Description of the more important Varieties. Ed. by William Jardine. James Duncan. London. 12mo, illus. *Hardwicke & Bogue.* 4s. 6d.

Black Hills. Mineral Wealth, Climate, Rain-Fall, and natural Resources of the Black Hills of Dakota. W. P. Jenny. Washington. 8vo. (*Van Nostrand. New York.*) $0.50.

Botany. The Wild Flowers of America, illus. by Isaac Sprague, text by George L. Goodale; to be issued in Parts by Subscription. Boston. *Hurd & Houghton.* (Announcement.)

Building Construction, Notes on —— Part II: Commencement of second Stage, or advanced Course. London. 8vo. *Rivingtons.* 10s. 6d.

Butterflies, British —— a complete Description of the Larvæ and Full-grown Insects of our native Species. James Duncan. Ed. by William Jardine. London. 12mo, illus. *Hardwicke & Bogue.* 4s. 6d.

Calculus. Remarks on the infinitesimal —— Richard Abbott. London. 8vo. (*Van Nostrand. New York.*) $0.50.

Chemical Philosophy, Introduction to the Study of—Principles of theoretical and systematic Chemistry. By Wm. A. Tilden. New York. 12mo. *Appleton.* $1.50.

Civil Engineers Club of the Northwest. Papers read before the—List of Members and Proceedings of Annual Meetings. Vol. I. Chicago. 12mo.

Coal. Spontaneous Combustion in Ships. Parliamentary Report. London. 8vo. 4d.

Coast Survey. Report of Superintendent of the U. S. for 1873. Washington. 4to. *Govt. Printing Office.*

Commercial Calculator, designed for the Use of Farmers, Mechanics, Business Men, and Laborers, containing convenient and valuable Tables, shewing the Value of Wheat, Corn, Rye, Oats, Barley, Cattle, Hogs, Hay, Coal, Lumber, Merchandise; simple and compound Interest at 6, 7, 8, and 10 per cent.; measurement of Boards, Scantlings, Timbers, Saw Logs, Cisterns, Tanks, Granaries, Corn-Cribs, Wagon-Beds; Time Tables, Wages Tables, etc., also entirely new and practical Methods of rapid Calculation. Christian Ropp, Jr. 16mo. *Ropp.* $1.00.

Constants of Nature. Part I. Specific Gravities, boiling and melting Points and chemical Formulæ. Part II. Table of specific Heats for Solids and Liquids. Part III. Tables of Expansion by Heat for Solids and Liquids. Washington. 8vo. *Smithsonian Inst.*

—— Specific Gravities, boiling and melting Points. First Supplement to Part I. Washington. 8vo. *Smithsonian Inst.*

Divining Rod. *Virgula Divina*; *Baculus Divinatorius* (Water Witching). Charles Latimer. Cleveland. 12mo. $0.50.

Forest Culture and Eucalyptus Trees. Elwood Cooper. New York. 12mo. *Cubery.* $1.50.

Freight Transportation, the American System of through —— as illustrated in the Operations of the Empire Transportation Co. Philadelphia. 12mo, illus.

Gas, metropolis—Surrey Side. Parliamentary Report. London. 8vo. 7d.

Geological Survey of Canada. Reports of Progress, 1874-75. Montreal. 8vo. *Dawson.*

—— Survey of Illinois. Vol. 6. Springfield. 8vo, illus. (*Van Nostrand. New York.*) $6.00.

—— Survey of Ohio. Vol. II. Part II, Paleontology. Columbus. 8vo.

Hydraulics. On the Changes in Tidal Portion of River Mersey, and its Estuary. James N. Schoolbred; with Abstract of Discussions. (Minutes of Proceedings. Institution Civil Engineers.) London. 8vo, illus. *Inst. Civil Eng.*

Industries. East London—W. G. Crory. London. 12mo. (*Van Nostrand. New York.*) $2.50.

Insects as Mimics. Insects as Architects. A. S. Packard, Jr. (Half-Hour Recreations in Natural History.) Boston. Each 12mo, illus. *Estes & Larriet.*

Iron. The American Iron Trade in 1876, politically, historically and statistically considered. James M. Swank. Philadelphia. 16mo. *Am. Iron and Steel Assoc.* $2.00.

Mechanics. Lessons in elementary—Introduction to the Study of physical Science; designed for the Use of Schools, Academies and scientific Institutions. Philip Magnus. With Emendations and Introduction by De Volson Wood. 2d ed. rev. New York. 8vo, illus. *Wileys.* $1.50.

Metric System, the universal —— —— prepared especially for Schools of Science, Engineers and Others. Alfred Colin. New York. 12mo. *Appletons.* $0.50

Moths, British—a complete Description of the Larvæ and full grown Insects of our native Species. James Duncan. Ed. by William Jardine. London. 12mo, illus. *Hardwicke & Bogue.* 2s. 6d.

Music, Theory of —, a practical Guide to the Study of Thorough-Bass, Harmony and Composition. W. R. Palmer. New York. *Church.* $1.

Patents. An Abstract of reported Cases relating to Letters Patent for Inventions. J. M. Goodeve. London. 8vo. *Sweet.* 18s.

Physical Geography. W. D. Cooley. London. 8vo. *Johnston.* 12s. 6d.

Physics, Elements of — or natural Philosophy. Neil Arnold. 7th ed. Ed. by Alex. Bain and Alfred S. Taylor. London. 8vo. illus. *Longmans.* 12s. 6d.

Pocket Companion of useful Tables and Information appertaining to the Use of wrought Iron for Engineers, Architects and Builders, compiled by A. G. Haumann. Pittsburgh. 16mo. (*Van Nostrand, New York*). $1.50.

Public Works, International Exhibit of Articles of Industry, Art, &c., at Philadelphia, in 1876. Sketch of the public Works in the Netherlands. Q. C. Van Keikuyks. Haarlem. 8vo.

Pyramids, Philetus, a Solution of the Mystery which for 4 000 years has shrouded the great Pyramids in Egypt. Charles Casey. 3d. ed. rev. and enl. Dublin. *Carson.* 2s.

Races of Mankind, being a Description of the Characteristics, Manners and Customs of the principal Varieties of the Human Family. Robert Brown. 4 Vols. London. 8vo, illus. *Cassell (New York).* $14.00.

Railroads. Annual Report of the Commissioners of Railroads and Telegraphs of Ohio, for year ending June 30th, 1875. Columbus. 8vo.

—— Annual Report of the State Engineer and Surveyor of State of New York, and of the Tabulations and Reductions from Reports of Railroad Corporations, for year ending September 30th, 1875. Albany. 8vo. *Van Benthusan & Co.*

Railway. The Intercolonial — a historical Sketch of the Inception, Location, Construction and Completion of the Line of Railway uniting the inland and Atlantic Provinces of the Dominion. Sandford Fleming, Montreal. 8vo, illus. *Dawson.* $3.00.

Railways. Returns for 1875. Parliamentary Report. London. 8vo. 1s. 2d.

Rain. Tables and Results of Precipitation in Rain and Snow, in the U. S., at some Stations in adjacent Parts of North America and in Central and South America. Charles A. Schott. Washington. 4to. *Smithsonian Inst.*

Sanitary. Filth Diseases and their Prevention. John Simon. Boston. 12mo. (*Van Nostrand, New York.*) $1.00.

—— Fresh Air in the House, and how to secure It. James Curtis. London. 8vo. *Ward & Lock.* 1s.

Silk Industry in America, a History prepared for the Centennial Exposition. L. P. Brockett. New York. 8vo. *Van Nostrand.* $1.50

Steam. Some Notes on the Advantages of using Steam expansively in Steam Engines, and particularly in variable Automatic Expansion as effected by Rider's Patent Expansion Gear, regulated by the Governor. Compiled by John C. Fell. London. 8vo, illus. *Spons (New York).* $0.60.

Temperature. Tables, Distribution and Variations of the atmospheric Temperature in the United States, Charles A. Schott. Washington. 4to. *Smithsonian Inst. (New York, Van Nostrand.)* $3.00.

Turnpike Roads, Scotland, Return. Parliamentary Report. London. 8vo. 3d.

Water Wheels. Principles of Construction and Efficiency of — —. William Donaldson. London. 8vo. *Spons (New York).* 5s.

Weather Charts and Storm Warnings. Robert H. Scott. London. 8vo, illus. *King.* 3s. 6d.

Wheels, a practical Treatise on the Teeth of —, with the Theory and Use of Robinson's Odontograph. S. W. Robinson. (Van Nostrand's Science Series.) New York. 18mo, illus. *Van Nostrand.* $0.50.

ADDITIONS TO

LIBRARY AND MUSEUM.

From American Iron and Steel Association, Philadelphia, Pa.:

American Iron Trade in 1876, politically, historically and statistically considered. James M. Swank. Philadelphia. 1876.

From Boston Public Library, Boston, Mass.:

City of Boston. Annual Report of Trustees of Public Library. 1876.

From Civil Engineers' Club of the Northwest, Chicago, Ills.:

Papers read before the Civil Engineers' Club of the Northwest. Constitution of the Club, List of Members and Proceedings of Annual Meeting. Vol. I. 1876. Chicago.

From David M. Greene. Albany, N. Y.:

Annual Report of State Engineer and Surveyor of State of New York, for year ending Sept. 30, 1875. Albany.

From Julius E. Hilgard, Washington,

Report of Superintendent of United States Coast Survey for 1873. Washington. 1875.

From Institution of Civil Engineers, London, England:

Excerpts from Minutes of Proceedings, Session 1875-6, Part I.

On Changes in Tidal portion of River Mersey, and its Estuary. James L. Shoolbred; with Abstract of Discussion.

From Charles Latimer, Cleveland, O.:

The divining Rod; *Virgula, Divina—Baculus Divinatorius* (Water Witching). Charles Latimer. Cleveland. 1876. (Copies for sale.)

From John McGee, Marietta, O.:

Railroads of Peru. Collection of Reports, Contracts and Documents relating to the Railroads of Peru. Arranged by Henry Meiggs Lima. 1871. (Spanish.)

Railroads of Peru Lima. 1873.

From Edward P. North, New York:

Photographs illustrating Blasts at Ahnepec (Wis.) Harbor.

From Paul Panayeff, Moscow, Russia:

Description of scientific Appliances for Study of mechanical Art in Workshops of Imperial Technical School of Moscow. 1876.

From Philip G. Peabody, New York:

Annual Catalogues of Columbia College, 1859-60, 1862-3, 1867-8, 1869-70, 1871-2, 1873-4, 1874-5, 1875-6.

Annual Catalogues of Law School of Columbia College, 1870-71, 1872-73.
Annual Report of President of Columbia College, made to Board of Trustees, June 2d, 1873. New York.
Catalogue of Officers, Alumni and other Graduates of Columbia College (originally King's College), New York, from 1754 to to 1870. New York.
College of Physicians and Surgeons, New York. Medical Department of Columbia College. New York. 1871.
Prospectus of Columbia College School of Mines, 1867-68, 1872-73.
Statutes of Columbia College and its associated Schools; permanent Resolutions and Orders of Board of Trustees. New York. 1874.

From George W. Plympton, New York:
Hydraulic Experiments at Roorkee. 1874-5. Allan Cunningham. Roorkee. 1875.

From Joseph D. Potts, Philadelphia:
American System of through fast Freight Transportation, as illustrated in Operations of Empire Transportation Co. Philadelphia. 1876.

From Thomas P. Roberts, Pittsburgh:
Report of Reconnaissance of Missouri River in 1872, Thomas P. Roberts. 1875.

From T. Guilford Smith, Buffalo, N. Y.:
Address of Alexander L. Holley, before American Institute of Mining Engineers, at Washington Meeting, Feb'y 22d, 1876. Philadelphia.
Annual Reports of Geological Surveys of Indiana. 1869, 1870 (2 copies), 1872. 1873, with Maps accompanying Survey of 1869. Indianapolis.
Annual Reports of Buffalo Park Commissioners, 1870-5. Buffalo. (5 numbers.)
Annual Report of Mercantile Library, Philadelphia, 1875.
Annual Report of Philadelphia Board of Trade, January 24th, 1876. (2 copies.)
Bay State Transportation League—a Bill to incorporate the Boston & Chicago Railway Trust Co. Boston, 1874.
Massachusetts Institute of Technology, Eleventh Annual Catalogue of Officers and students, with Statement of Courses of Instruction. 1876. Boston.
Massachusetts Institute of Technology; Annual Catalogue 1875-6. Centennial Exhibition.—Catalogue of Models, Instruments, Samples, Papers and Drawings exhibited. Department of Architecture: President's Report. Sept. 30. 1876. Boston. (4 numbers.)
Programme of 26th Meeting of American Association for Advancement of Science, August 23d, 1876. Buffalo, N. Y.
Supplementary Return of Correspondence and Papers, relating to North Simcoe Railway. Jan'y 10. 1876.
Tests of Union wrought Iron Beams, used at Fourth Avenue Improvement, New York.
The American Iron Trade, a monthly Journal. New York, 1874.

From Henry T. Walling. Boston, Mass.:
Atlas of Dominion of Canada, with general Descriptions. Drawn, compiled and edited by H. T. Walling. Montreal, Toronto, London. 1875.

From John Whitelaw, Cleveland, O.:
Annual Report of the Board of Trustees of Water Works of Cleveland. 1875. Cleveland.

ANNOUNCEMENTS.

MEETINGS.—The next *stated* meeting of the Board of Direction will be held Wednesday, October 4th, at 3 o'clock, P. M., for the transaction of regular business.

The next *regular* meeting of the Society will be held Wednesday, October 4th, at 8 o'clock P. M., when ballots for members will be canvassed, a "Uniform System of Railroad Accounts and Returns" considered; selections from the Secretary's correspondence presented, and other matters taken up.

At the *stated* meeting of the Society, October 18th, "Memoirs of American Engineering," a paper by John B. Jervis, Honorary Member, will be read.

The Twenty-fourth Annual Meeting of the Society will be held Wednesday, November 1st, at 10 o'clock A. M. The Annual Report of the Board of Direction on the affairs of the Society, will be presented; officers for the ensuing year elected; the Normal Medal awarded; time and place of the Ninth Annual Convention fixed; ballots for members canvassed, and other important business done.

An informal dinner for members of the Society and invited guests will be had in the evening.

PAPERS ON ENGINEERING SUBJECTS, giving results of practice, or in discussion of pertinent theoretical questions, are desired from members of the Society; their comments (whether or not present at meetings of the Society), upon papers published in Transactions, are solicited, and they are urged to contribute from note-books and other similar records, whatever may bear upon the subjects considered, or refer to other practical topics. A list of subjects relating to the practice of engineering and its connection with kindred art and public affairs, on which papers are desired may be found on page 51, Vol. I.

ILLUSTRATIONS OF PAPERS presented for publication should be distinctly drawn in *broad, sharp* lines, upon *white, smooth* (not "egg" or enameled) paper, with perfectly (not gloossy or grey) *black* ink, to a scale twice or thrice greater than the print is to be; which in no case should require folding in more than one direction, (*i. e.*, the depth of plate, as inserted in Transactions, should not exceed 9 inches). Shades are to be produced by variations in

size and spacing of *black* lines; no brush work or colors are admissible. Unless figures and letters can be *well* put in, simply pencil them, leaving the engraver to insert them in the plate. Always put a scale upon each drawing.

EXTRA COPIES.—A member may order 25 copies without charge, and as many more as desired at cost of paper and presswork, of any paper he contributes, by giving notice to the Secretary of the number required—*before* the paper is printed.

LIST OF MEMBERS.

ADDITIONS.

	Date of Election.
ALBERT, JOHN S.....(Ch. Eng. U. S. Navy) Ch. of Bureau of Machinery, International Exposition, Philadelphia, Pa.....Sept.	6, 1876.
CARTWRIGHT, HENRY.....Mechanical Engineer, Philadelphia, Pa..... "	" "
EMONTS, WILLIAM A. G. [J.].Ass't Eng. North Penn. R. R., Philadelphia, Pa..... "	" "
FLINT, CHARLES R. . [F·]..Eulogio Delgado, Lima, Peru, ...June	7 "
HOOD, WILLIAM.....Ass't Eng. S. P. R. R., San Francisco, Cal.....Sept.	6 "
LUCAS, D. JONES [J.].....Res. Eng. Empire Transportation Co., Foxburg, Pa..... "	" "
PHILBRICK, PHILETUS H.....Prof. Civil Eng., Iowa State University, Iowa City..... "	" "
SCOVILL, EDWARD T.....Civil Engineer, Cleveland, O..... "	" "
STRATTON, FRANKLIN A....Civil Engineer, U. S. N., Philadelphia, Pa.....May	3, "
WILSON, HENRY W.....Ass't Eng. P. R. R., 233 South 4th St., Philadelphia, Pa.....Sept.	6, "

CHANGES AND CORRECTIONS.

MAXWELL, JAMES R.....Newark, Del.

NICHOLS, WILLARD A.....Ass't Eng. Dept. of Docks, 117 Duane street, N. Y.

PONTZEN, ERNEST.....Strauchgasse, 1, Vienna, Austria.

SEARS, CLINTON B.....Lieut. of Engs. U. S. A., Ass't Prof. Military Academy, West Point, N. Y.

WARD, CHARLES D.....Colchester, Conn.

RESIGNED.

STONE, ANDROS B.....20 Nassau street, New York.....Oct. 3, 1876.

American Society of Civil Engineers.

PROCEEDINGS.

Vol. II, October, 1876.

MINUTES OF MEETINGS.

(Abstract of such as may be of general interest to members.)

OF THE SOCIETY.

SEPTEMBER 20TH, 1876.—A stated meeting of the Society was held at 8 o'clock P. M.

Reading of the paper, "Principles of tidal Harbor Improvement as applied at Wilmington, Cal.," by Clinton B. Sears, Engineer Corps, U. S. A., was concluded, and a discussion followed. A communication from Louis Y. Schermerhorn, of Chicago, Ill., relating to behavior of a steam boiler during a blast on a rocky reef in one of the northern lakes, was presented, and the remainder of the session spent in conversation.

OCTOBER 4TH, 1876.—A regular meeting was held at 8 o'clock P. M.

The vote on admission to membership was canvassed, and the following were elected: Members—John R. Scupham of San Francisco, Cal., and Albert G. Warfield of Florence, Md.; and Junior—Frank W. Whitlock of Great Barrington, Mass.

Communications* from George W. R. Bayley of Port Eads, La.; Charles Paine of Cleveland, O., and Paul Panayeff of Moscow, Russia, were read; the remainder of the session was spent in conversation.

OF THE BOARD OF DIRECTION.

OCTOBER 4TH, 1876.—A stated meeting was held at 3 o'clock P. M.; proposals for admission to the Society and preparation of the Annual Report of the Board were considered, and other routine business done.

The Librarian was instructed to report upon the state of the library, and to recommend measures to increase its usefulness to members.

* See Selections from Correspondence, page 118.

NOTES AND MEMORANDA.

Sketches of Engineering Exhibits at the International Exhibition; of France.*

Between the Art Annex Buildings and the Vienna Bakery stands a somewhat peculiar structure of brick, which contains the collection of models, charts, drawings and documents sent to the Centennial Exposition by the Ministry of Public Works of France. The building is in dimensions about 50 by 100 feet, is of brick in three colors, has an iron frame, is lighted entirely from the top through a shaded skylight, and is tastefully decorated in polychrome.

The construction of this expensive building, which contains nothing beside the engineering exhibit, is a mark of the deep interest felt in France on this subject, and also of the expectation on the part of the French engineers of a corresponding appreciation of their efforts by the profession in the United States.

An engineer of the corps of "*Ponts et Chaussees*," M. Lavoinne, who is also one of the international judges, was in charge of the Exhibit, and with his assistants gave a pleasant and instructive reception to inquiring engineers.

The collection has been made under the direction of the Ministry of Public Works, by the "*Ponts et Chaussees*," the "*Mines*," and the great railway companies. A description has been prepared and a careful translation made, which, in a volume of over 400 pages, gives in excellent English very full information in reference to the exhibits, including plans, methods and details of construction, names of engineers and cost of the various structures. The exhibits are systematically classified and described under the general heads of roads, railways, internal navigation, maritime works, light-houses and beacons, elevation and distribution of water and the special work of "*Mines*."

As the best preliminary to the examination of the works of the "*Ponts et Chaussees*," there is presented a large painted map of France on a scale of $\frac{1}{320\,000}$ with an explanatory octavo volume. This map shows the lines of communication comprising national and departmental roads, railways, canals and navigable rivers. It also represents the water sheds, the lines of maritime communication, the depths of the seas near the shore and the luminous ranges of the light-houses, showing a well protected coast. The principal towns are shown by gilt headed buttons. The country is seen to be well covered by railway communication, and also to have a considerable system of navigable waterways.

The methods of road construction are fully described in the volume compiled by the officers of the "*Ponts et Chaussees*," which includes drawings of the various kinds of roads, with their foundations, drainage systems, curbs, gutters and, in fact, all accessory details.*

One road viaduct and three road bridges are represented by models. The viaduct is that of Dinan on the Rance, 315.5 metres in length. It has ten semi-circular arches of 16 metres span and 1 metre thickness at the key. The roadway is 41.3 metres above the canal passing under it. The model in its general appearance recalls the High Bridge over the Harlem river, New York.

A handsome model in metal, with mirror water surface, represents the Bridge of Arcole at Paris. This is of iron, of a single span of 80 metres and a rise of 6.12 metres. Its breadth is 20 metres. It is formed of 12 ribs, each composed of an arch of riveted plates and a string piece of T iron united by spandrels of double T iron. It is strongly braced.

The Swing Bridge at Brest is also shown by a full model and a model of the turn-table towers. This bridge consists of two distinct halves, which turn horizontally on piers and when closed meet and are bolted to each other at the centre. The land end of each half is in the form of a chest, which holds the counterpoise weight. The machinery of rotation and the arrangement for relieving this machinery from the pressure of the bridge when repairs are required are interesting.

The Bridge of Saint Sauvern is a single stone semi-circular arch of 42 metres span. The centering of this arch is shown in model,

* Continued from page 113.

* A copy of this book has been already presented to the Centennial Commission of the Society, and will be a valuable addition to the library.

and was supported by a high central trestle. The height of the roadway above the river is 65.5 metres.

Four iron railway bridges or viaducts are shown. One of these consists of seven cast iron arches of 60 metres span and 5 metres rise. The other three are lattice girders upon high iron piers. The spans are about 50 metres and the height of piers from 33 to 57.5 metres.

There are also shown, a stone two-track railway viaduct of seventeen elliptic arches of 30 metres span, and a high stone viaduct of twelve arches of 22 metres span, the roadway being 54 metres above the rock below.

The viaduct of the Point du Jour provides a bridge for foot passengers and carriages, and above that a viaduct for the railway. The lower bridge has five elliptical arches of 30.24 metres span, and the upper has thirty-one semi-circular arches of 4.8 metres span. All are in stone.

The details of the Paris terminus of the Orleans Railway are shown. This depot covers about 25 acres. Its main feature is the roof of the great hall, 51.5 metres span and 280 metres long. The ribs are 10 metres apart, and are of a combination of cast and wrought iron on the Polonceau system.

A description is given, with tables of tests and with various patterns, of the different types of steel rails adopted by the French railway companies. There are also portfolios of drawings showing the rolling stock in use and general descriptions of the peculiar features of French railways. Light curves and grades are insisted upon and the construction of the permanent way is very substantial. The government regulations provide for many details both as to construction and management. The block system is in use on various lines. The speed of express trains reaches 50 or 55 miles per hour.

The French engineers claim that the construction of their cars brings the relation of dead weight and actual load to the most favorable conditions.

The passenger carriages have four wheels, except on the lines of one company, where 6 wheels are used. First class carriages have seats for 24, second class for 40 and third class for 50 persons. Cast iron wheels are not used. The establishment of a communication between the passengers and the persons managing the train has not yet been accomplished.

The locomotives have generally 6 wheels; the forward truck or "bogie" is not used.

An interesting set of models and drawings shows the means taken to improve the navigation of the Seine, the Youne and the Maine. The navigation between Paris and Auxerre was formerly intermittent, and dependent upon temporary risings and flushes of water by the opening and closing of the passage at fixed points. A continuous navigation has now been secured, by the construction of dams and weirs with a peculiar system of movable wickets. The details of these and of the locks and other constructions connected with the improvement of navigation are shown very fully. The navigation of the lower or maritime Seine has also been made free for a draught of over 5 meters from Rouen to Havre. This has been accomplished by narrowing the channel by means of stone embankments parallel to the stream.

The entrance to the port of Bayonne at the mouth of the Adour is obstructed by a gravel bar. Jetties have been constructed to concentrate the river flow upon this bar, and apparently have been measurably successful. These jetties were built fifteen years ago with timber piles, but at the end of five years the *teredo* had destroyed a large portion of the work. Iron tubes have now been substituted, sunk by compressed air and filled with beton. It has been found that open jetties—that is to say, jetties whose stone filling is brought up no higher than 2 meters below the lowest tide—are effective where the old closed jetties, with the stone brought up to the level of high tide, failed. (The tides on the Atlantic coast of France rise and fall from 2.5 to 5 meters.)

At the mouth of the Rhone, on the Mediterranean, repeated attempts to lower its bar having failed, a canal of 3 330 meters in length has been constructed with a lock at its river end. The lock is 22 meters wide, and has 160 meters length of chamber. The water in the canal is 6 meters deep. The lock gates are of rolled iron frames covered with sheet iron, so as to form a water-tight chest, which is arranged so as to give enough buoyancy to reduce the weight and lessen the strain on the pivots. The water freely entering a part of this chest makes this weight and strain always the same, whatever the depth of water.

The lock at the port of Dunkerque, 21 meters wide and 59 meters long, is shown by a very handsome model in stone, wood, iron and bronze.

An iron aqueduct, carrying a canal over a river, is also represented. It is 48 meters long, 11 meters wide, and 2.55 meters deep.

Maritime works are illustrated by an atlas of the ports of France, by models of several locks, and by drawings of the docks, basins and constructions at several of the principal ports.

At St. Nazaire, two great basins have been built, 720 meters long and from 90 to 160 meters wide, protected by wooden jetties and entered by two locks. These locks admit trans-Atlantic steamers, and are 25 meters in breadth. One lock has wooden, the other iron gates, and a preference is given, as to relative cost and durability, to the iron gates.

At Bordeaux, a basin of about 25 acres area is now in progress of construction. This will be surrounded by vertical quay walls 1 800 meters long. The depth of water in the basin is to be generally 8 meters. The basin is entered by two locks of different dimensions placed close together, the largest of which is 22 meters wide and 152 meters long between gates. A dry dock, capable of admitting the largest steamers, will also be constructed. The foundations of the walls of the locks are perforated blocks of masonry, sunk by their own weight through about 13 meters of mud to a stratum of gravel. These masses of masonry were 6 meters wide, 9 metres thick and from 16 to 35 meters long, and each has one or more vertical shafts. The mud was removed from these shafts by excavation and by the use of centrifugal pumps when the underlying water forced itself up. When the desired depth was reached in the gravel, the shafts were filled with beton. These blocks having been laid to form the walls of a rectangle, 205 meters long and 57 meters wide, the interior space was excavated with the aid of pumps, and the invert of the locks laid therein on the gravel. The whole work is water-tight in all parts. The quay walls are built upon a succession of semi-circular arches of 8 meters span, which rest upon similar perforated blocks 5 meters square, sunk into the gravel by the same process.

At the port of St. Jean de Luz, a mole is in progress, the foundation of which is partially made with artificial blocks. These blocks are composed of two parts of broken stone and one of mortar; the mortar being 1 cement to 2½ sand. These blocks are made two months before they are placed in the foundations.

The improvements at the port of Marseilles are shown by handsome drawings and by a model. These improvements consist of extended basins and dry docks, one of which is 141.5 meters in length. The exterior dyke or breakwater is formed of natural stone in the body of the work and of very large artificial blocks on the exterior, resisting the action of the waves.

A bridge of peculiar construction is built across one of the water-ways. It is either a swing or a draw bridge, as occasion requires, being turned horizontally for the passage of masted vessels, but only partially lifted for the passage of barges.

The elevation and distribution of water are represented by drawings and models of aqueducts, dams, reservoirs and pumps. The pumps at Condé can raise 260 gallons per second a height of 28 meters. The pumps are three in number and of vertical double action, cylinders, 95 centimeters in diameter, with a stroke of one meter, and are worked up to 9 or 10 strokes per minute; special merit is claimed for the peculiar clack valves employed. The pumps are worked by five Kœchlin turbines.

The dams represented are those of the Furens, the Bau and of Mittersheim.

The dam of the Furens is 50 meters in height, 5.7 meters in width at the top and 49.04 meters at the bottom. The dam is constructed of rough stone masonry in Theil lime. Its plan is the arc of a circle of 100 meters chord and 5 meters versed sine, and the faces have curved profiles.

The dam of the Bau is generally similar to the above.

The dam of the Mittersheim is 332 meters long, 9 meters high, 6 meters wide at top and 37 meters at the base. It is formed of puddled earth faced with masonry on the water side. A siphon weir is in use here, which, by means of an attached tube, automatically regulates the speed of delivery in direct reference to the level of water in the reservoir.

The aqueduct of Roquefarom is shown by models and drawings. It is 393 meters in length, 83 meters high, and 45 meters wide at top. It has three stages of arches: the lower 15 meters in span, the middle arches 16 meters span, and the upper arches 5 meters span. The work is built in stone, the water trough being brick.

The number and condition of the lighthouses and beacons on the coast of France are shown by a large volume with maps. There are also drawings and models of candelabra and of various kinds of lighting apparatus, and full working examples of lamps, lens and appliances. Details are given of several of the lighthouse towers, some in masonry and some in iron.

The construction of the foundations of the light of Ar-men presented great difficulties. Holes were bored one meter apart upon a rock so difficult of access and so constantly covered

by rough seas that during a whole season only seven landings were effected and eight hours of work accomplished, during which time fifteen holes had been bored. The workmen were provided with life belts, and were sometimes swept into the sea. Galvanized wrought iron bolts were fixed in the holes, and about these masonry of small undressed stone, with very quick setting cement, was laid. The work was begun in 1867, and in 1875 there had been 455 cubic meters of masonry built, and the work was 2.6 meters above high tide. During these nine years only 127 landings were made, and 329 hours of working time possible. The cement first used was Packer-Medina, but the Portland has been substituted as better resisting the action of sea-water.

The officers of the "*Mines*" exhibit a detailed geological map of France as far as completed, and various documents, maps and instruments pertaining to their department. They also exhibit an interesting agricultural map of the country showing the different cultures. Twenty-two albums of photographs are exhibited and contain views of many of the principal works executed in France, including roads, bridges, railways, navigation and harbors works, canals, water works, light-houses and public buildings.

There is also given in documents full information as to the School "*des Ponts et Chaussees*" and the School of Mines.

The only engineering exhibit at the Centennial Exhibition at all comparing in extent with that just described, is that of the Commission of the American Society of Civil Engineers. Of course, a more extended notice of the French exhibit, and a fuller discussion of its various details, would be a most pleasant task.

The suggestion is again made that France and her engineers have shown, by this beautiful collection, not only the high rank they themselves give to our profession, but also and decidedly, a belief that American engineers would appreciate their labors and reciprocate, as occasion occurs, this substantial international greeting.

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

American Progress, a national Manual of Facts and Figures; historical, biographical, documentary, statistical, financial and political. 1492 to 1876. ed. by E. O. Haven. New York. 8vo. *Treat.* $2.00.

Apparatus (hydraulic) for Loading Minerals from Railway Wagons into Ships. William H. Thomas; (Minutes of Proceedings, Institution of Civil Engineers). London. 8vo, illus. *Inst. Civil Eng.*

Animals, the geographical Distribution of —. A. R. Wallace. New York. *Harpers.* (Announcement.)

Architects and Engineers, Transactions of the Society of —— at Hanover. Vol. XXII. Hanover. 4to, illus. (German.)

Architecture, rural Church ——, comprising a Series of Designs for Churches exemplified in Plans, Elevations, Sections and Details, with practical Descriptions, by Upjohn, Renwick, Wheeler, Wells, Austin, Stone, Cleaveland, Backus, Reeve and Eveleth; new and rev. ed. New York. 4to, illus. *Judd.* $6.00.

Almanac. American Ephemeris and nautical Almanac for 1879. Washington. 8vo. *Gov. Printing Office.*

Biology, a Course of practical Instruction in elementary ——. T. H. Huxley, as. by H. N. Martin, London. 16mo. *Macmillan,* (*New York.*) $2.00.

Bridge Building, modern American ——. C. O. Gleim. Part III. (Minutes of Proceedings, Society of Architects and Engineers of Hanover.) Hanover. 4to, illus. (German.)

Birds, Tiny Houses and their Builders, being a graphic Account of the Habits of Birds and their various Methods of Building their Tiny Houses. London. 4to, illus. *Cassell.* (*New York.*) $2.50.

Boiler, Use and Abuse of the Steam ——. Stephen Roper. Philadelphia. 12mo, illus. *Claxton, R. & H.* (Announcement.)

Botany, systematic ——. J. H. Balfour. New York. 16mo, illus. *Putnams.* $0 75.

Bridges. On the Theory and Calculation of Continuous Bridges. Mansfield Merriman. (Van Nostrand's Science Series.) New York. 18mo. *Van Nostrand.* $0.50.

Building Construction, Notes on ——. Part 2. Commencement of second Stage, or advanced Course. Philadelphia. 8vo, illus. *Lippincott.* $3.50.

Color, The Theory of — in its Relation to Art and Art Industry. Wilhelm von Bezold, trans. from the German by S. R. Koehler. with Introduction by Edward C. Pickering. Boston. 8vo, illus. *Prang.* $5.00.

Costumes, Planche's Cyclopædia of —— ; or Dictionary of Dress, regal, ecclesiastical, civil and military, from the earliest Period to the Reign of George III., including Notices of contemporaneous Fashions on the Continent. New York. 4to, illus. *Bouton.* (Announcement.)

Damages, the Law of ——. George W. Field. New York. 8vo. *Mills.* $7.50.

Darwiniana, Essays and Reviews, pertaining to Darwinism. Asa Gray. New York. 12mo. *Van Nostrand.* $2.00.

Electricity, an Introduction to the Theory of ——, with numerous Examples. L. Cumming. New York. 8vo, illus. *Macmillan.* (Announcement.)

—— and the electric Telegraph. G. B Prescott. New York. *Appletons.* (Announcement.)

Encyclopædia Britannica, a Dictionary of Arts, Sciences and general Literature. Ninth ed. (American Reprint.) Vol. 4. Ath.-Boi. Philadelphia. 8vo. illus. *Stoddart.* $5.00.

Engineering Papers. Abstracts of — in foreign Transactions and Periodicals. Ed. by James Forrest. (Minutes of Proceedings. Institution of Civil Engineers. Vol. XLV.) London. 8vo. *Inst. Civil Eng.*

Evolution, Contemporary ——. St. George Mivart. New York. *Appletons.* (Announcement.)

—— direct Evidence of ——. T. H. Huxley. New York. *Appletons.* (Announcement.)

Excavations and Embankments, a universal Table for ——. W. Zimmerman. New York. *Wiley's.* (Announcement.)

Exhibition, an illustrated Catalogue; the Masterpieces of the U. S. International Exhibition. 1876. Fine Arts by Edward Strahan; Industrial Art by Dalton Dorr; Mechanics and Science by Joseph M. Wilson. 3 Vols. Philadelphia. 4to, illus. *Gebbie & Barrie.* (Announcement.)

Facine Work at the Outfalls of the Ten Rivers and Reclamation of the Foreshore. William H. Wheeler, with Abstract of Discussion. (Minutes of Proceedings, Institution of Civil Engineers.) London. 8vo, illus. *Inst. Civil Eng.*

Fixtures, a Treatise on the Law of ——, embracing the leading Decisions upon the Subject, both American and English, bringing the Law down to the present Time. Ransom H. Tyler. Albany. 8vo. *Gould.* $7.50.

Forces, Applications of physical ——. Amedee Guillemin; trans. by Mrs. Lockyer; ed. by J. Norman Lockyer. New York. *Macmillan.* (Announcement.)

Geology, Field ——. W. Henry Penning, with a Section on Palæontology. A. J. Jukes Brown. London. 12mo. (*Van Nostrand, New York.*) $3.00.

Geometry and Conic Sections, Manual of ——. William G. Peck. New York. 12mo. *Barnes.* $1.60.

Graphic Statics, Elements of ——. Karl Von Ott; trans. from the German by George Sydenham Clarke. London. 8vo, illus. *Spons* (*New York*). $2.00.

Heraldry, Manual of ——, being a concise Description of the several Terms used, and containing a Dictionary of every Designation in the Science. New ed. London. 8vo, illus. *Virtue.* 2s.

Iron. On the Metallurgy of ——. Herman Wedding. New York. *Putnams.* (Announcement.)

Jetties. Report on the Mississippi ——, August 18, 1876. James B. Eads. St. Louis. 8vo, maps.

Labor, Talks about ——, and concerning the Evolution of Justice between Laborers and Capitalists. J. N. Larned. New York. 12mo. *Appleton.* (Announcement.) $1.50.

Lighthouses, Memoir upon the Illumination and Beaconage of the Coasts of France. Leonie Reynard; trans. from the French by Peter C. Hains. 4to, illus. Washington. *Gov. Printing Office.*

Mechanics, applied ——. William Rossiter. New York. 16mo, illus. *Putnams.* $0.75.

—— Elements of analytical ——. DeVolson Wood. New York. 8vo, illus. *Wiley.* $3.00.

—— theoretical ——. William Rossiter. New York. 16mo, illus. *Putnams.* $0.75.

eter, On a current ——, a Deep-Sea Current Indicator, and an improved Ship's Log. Benjamin T. Moore. (Minutes of Proceedings, Institution of Civil Engineers. London. 8vo, illus. *Inst. Civil Eng.*

Mines and Mining, American ——. H. S. Osborn, Philadelphia. *Baird.* (Announcement.)

Money Question. The Legal-Tender Paper monetary System of the United States. William A. Berkey. Philadelphia. 12mo, *Baird.* $1.50.

Ornithology, Wilson's American ——; or Natural History of the Birds of the United States, with Notes and Life of Wilson, by William Jardine. New York. 8vo., illus. 3 vols. *Boulon.* (Announcement.)

Plants, the Analysis of ——, intended for Schools, Colleges and independent botanical Students. M.W.Harrington, Ann Arbor. 4to, illus. (*Van Nostrand, New York.* $0.90.

Political Economy, an Introduction to — —. Arthur Latham Perry. New York, *Scribner W. & A.* (Announcement.)

Railways. Returns for 1875. Parliamentary Report. London. 8vo. 1s. 2d.

Sanitary. Health and Comfort in House Building. 2d ed., with Supplement. London. 8vo. (*Van Nostrand, New York.*) $2.00.

Science, the Warfare of ——. A. D. White. New York. 12mo. (*Van Nostrand.*) $1.00.

Senses, the Five Senses of Man. Julius Bernstein. New York. 12mo. illus. (*Van Nostrand.*) $1.75.

Sewers and Drains for populous Districts, embracing Rules and Formulas for the Dimensions and Construction of Works of Sanitary Engineers. Julius W. Adams. New York. *Van Nostrand.* (Announcement.)

Shipping. Tables showing Progress of ——. Parliamentary Report. London. 8vo. 6d.

—— the Fleets of the World; the Galley Period. Foxhall A. Parker. New York. 8vo. illus. *Van Nostrand.* (Announcement.)

Sound, the Theory of ——. Prof. Balserna. (International Scientific Series.) New York. *Appletons.* (Announcement.)

Telegraph Engineers — — Journal of the Society of — —, including original Communications on Telegraphy and Electrical Science. No. 12. Ed. by Frank Bolton and J. Sivewright. London. 8vo. illus. *Spons.* (*New York.*) $2.00.

Telegraphy, Electro-Telegraphy. Frederick S. Beechy. London. 12mo. illus. *Spons.* (*New York.*) $0.60.

Telescope, the modern ——. Lecture delivered at the Royal Institution. J. N. Lockyer; with Notes and Additions, by G. M. Seabrook. London. 8vo. illus. *Macmillan.* (*New York.* Announcement.)

Trade and Navigation. Accounts for July. Parliamentary Report. London. 8vo. 5d.

Water Works, History of the Boston—from 1868 to 1876. Boston. 8vo.

Varnishes, a practical Treatise on the Manufacture of—by Reffault, Vergnaud and Loussaint, Philadelphia. *Baird.* (Announcement.)

Vegetable Kingdom, Darwin on the Results of Cross and Self Fertilization in — —. New York. *Appletons.* (Announcement.)

Zoology, comparative, structural and systematic, for use in Schools and Colleges. Jas. Orton. New York. 12mo. illus. (*Van Nostrand.*) $3.00.

ADDITIONS TO

LIBRARY AND MUSEUM.

NOTE: "Copies for distribution" named in this list will, in order of receipt, be sent to members who apply, until the supply is exhausted.

DONATIONS ARE ACKNOWLEDGED AS FOLLOWS:

From John Bogart, New York:
Department of Public Parks, Proposals for Estimates and Specifications as follows, (2 copies, each):
Improving and Constructing Riverside avenue, between 72d and 130th streets.
Regulating and Paving with Trap Block Pavement, Roadway in Washington Square, from Fifth Avenue to South Fifth Avenue.

From Clarke, Reeves & Co., Philadelphia:
Useful Information for Architects, Engineers and Workers in Wrought Iron. Phœnix Iron Co. (Copies for distribution by Centennial Commission.)

From J. H. C. Coffin, Washington:
American Ephemeris and Nautical Almanac for 1879. Washington, 1876.

From Joseph P. Davis, Boston, Mass.:
History of Boston Water Works from 1868 to 1876. Boston.
Report of Cochituate Water Board, City of Boston, for year ending April 30, 1876.

From Iron and Steel Institute, London:
Journal of the Institute, No. 1, 1876. London.

From James B. Eads, St. Louis:
Report on the Mississippi Jetties. James B. Eads, August 1876. (Copies for distribution.)

From James T. Gardner, Albany, N. Y.:
Elevation of certain Datum Points on the great Lakes and Rivers and in the Rocky Mountains. James T. Gardner. Washington, 1875. (2 copies.)

From C. O. Gleim, Cologne, Germany:
Modern American Bridge Building. Part II. C. O. Gleim. Minutes, Proceedings Society of Architects and Engineers of Hanover. (German.)

From Peter C. Haines, Maj. of Engineers, U. S. A. Washington;
Memoir upon Illumination and Beaconage of Coasts of France. Leonie Reynaud. trans. by Peter C. Haines. Washington, 1876.

From Robert C. Hall, U. S. A., West Point, N. Y.:
Official Register of Officers and Cadets of U. S. Military Academy, West Point. June, 1876.

From Institution of Civil Engineers, London:
Excerpts from Minutes of Proceedings, Session 1875-6, Part III., as follows:
Abstracts of Papers in Foreign Transactions and Periodicals.
Facine Work at Outfalls of the Ten Rivers, and Reclamation of the Foreshore. William H. Wheeler; with Abstract of Discussion.
Hydraulic Apparatus for Loading Minerals from Railway Wagons into Ships. William A. Thomas.
On a Current Meter, a Deep Sea Current Indicator, and an improved Ship's Log. Benjamin T. Moore.

From William J. McAlpine, Babylon, N. Y.
Mechanical Science. Parts I-III, Mechanical Effects, Motive Power, Formulæ; Parts IV, V, Weights and the Science of Weighing; Parts VI, VII, Bridges; Parts VIII, IX, Water Works and Hydraulic Motors. (German). 4 vol., folio, illus. Leipzig, 1724-1774.
Miscellaneous Plans and Drawings, illustrating—
Water Works and Tunnel at Albany, and Water Works at Buffalo, Chicago and New York.
Construction of U. S. Dry Dock at Brooklyn.

From Paul Michailoff, St. Petersburgh, Russia:
Memoir on the Project of N. Pooteeloff, for Construction of St. Petersburg Commercial Port. (Russian.)
Official Journal of Public Works of Russia, 1868-9. 2 Vol. (Russian.)
Statistics of the Railroads of Russia 1867-8, 70-2, 74-5. 14 vol. (Russian.)

From William H. Paine, Brooklyn, N. Y.:
Specifications for Steel Cable Wire, for the East River Suspension Bridge. (Copies for distribution.)

From Francis J. Palmer, New York:
Bombay Harbor, Survey, 1875.

From Philip G. Peabody, New York:
Annual Report of President of Columbia College, June, 1871. New York.
The Metric System of Weights and Measures. F. A. P. Barnard. New York.

From Smithsonian Institution, Washington, D. C.:

Constants of Nature. Part I, Specific Gravities; Boiling and Melting Points, and Chemical Formula. Part II, Table of Specific Heats for Solids and Liquids. Part III, Tables of Expansion by Heat for Solids and Liquids, Specific Gravities, Boiling Points and Melting Points. First Supplement to Part I.

Tables, Distribution and Variations of the atmospheric Temperature in the United States, and some adjacent Parts of America. Charles A. Schott. Washington, 1876.

Tables and results of Precipitation, in Rain and Snow in the United States—at some Stations in adjacent Parts of North America, and in Central and South America. Charles A. Schott. Washington, 1872.

From J. Herbert Shedd, Providence, R. I.:

Tenth Report of Board of Water Commissioners, City of Providence, on Sewers, September, 1876. (Copies for distribution.)

Tenth Quarterly Report of Water Commissioners, City of Providence, September, 1876. (Copies for distribution.)

From the Society of Architects and Engineers at Hanover:

Transactions, Vol. XXII, No. 3, Hanover, 1876. (German.)

From Cook Talcott, High Bridge, N. J.:

Elementary Principles of Carpentry, a Treatise on Floors, Roofs, Bridges, Timber, &c. William Tredgold. Philadelphia, 1837.

Operative Masonry, a Treatise on Building Stones, Clays, Cements, &c. E. Shaw. Boston, 1832.

From Union Iron Co., Buffalo, N. Y:

Book of Shapes, with Description of Works of Union Iron Co., Buffalo, 1876. Volume and Map.

From John D. Van Buren, Albany, N.Y.:

Photographs illustrating Bridge at Schenectady, N. Y.

Report of State Engineer and Surveyor on Contracts for extraordinary Repairs.

Supreme Court, State of New York, The People against Mohawk Bridge Co. Schenectady, 1872.

From D. Van Nostrand, New York:

Practical Treatise on Teeth of Wheels with Theory and Use of Robinson's Odontograph. S. W. Robinson. New York, 1876.

Theory and Calculation of Continuous Bridges. Mansfield Merriman, Jr. New York, 1876.

Van Nostrand's Monthly Record of Scientific Literature. Nos. 25–50. New York, 1876.

From Thomas J. Whitman, St. Louis, Mo.:

Annual Report of Water Commissioners of St. Louis. May, 1876.

From John Wiley & Sons, New York:

Elements of Analytical Mechanics. De Volson Wood. New York, 1876.

From William E. Worthen (of Committee of Experts.) New York:

Lawrence Water Works. Reports on Trial of Duty and Capacity of the Pumping Engines. May, 1876. (600 copies.)

From Miscellaneous Sources:

Annual Report of Commissioners of Railroads and Telegraphs of Ohio, for year ending June 30, 1875. Columbus.

Annual Report of Secretary of Internal Affairs of the Commonwealth of Pennsylvania, 1874–5. Part 3, Industrial Statistics, Vol. 3. Harrisburg, 1876.

Diamond Stone Saw, a lithograph.

Evans' Advertising Hand-Book, Centennial Edition. Boston.

International Exhibition of Articles of Industry, Art, &c., held at Philadelphia in 1876; a Sketch of the Public Works in the Netherlands, by L. C. Van Kerkwyk. Haarlem, 1876.

Photographs of Anchorage and Piers of East River Bridge. (2 copies.)

Report of Geological Survey of Ohio. Vol. II, Part II, Palæontology. Columbus. 1875.

ANNOUNCEMENTS.

MEETINGS.—The next (an adjourned) meeting of the Board of Direction, will be held Wednesday, October 16th, 1876, at 3 o'clock P.M., for preparation of the Annual Report upon the affairs of the Society.

The next *stated* meeting of the Society will be held Wednesday, October 18th, at which "Memoirs of American Engineering," a paper by John B. Jervis, Honorary Member, will be read, and advancement of the profession considered. After the formal session, an hour will be given to conversation.

The Twenty-fourth Annual Meeting of the Society will be held Wednesday, November 1st, at 10 o'clock A. M. The Annual Report of the Board of Direction, on the affairs of the Society, will be presented; officers for the ensuing year elected; the Norman Medal awarded; time and place of the Ninth Annual Convention fixed; ballots for members canvassed, and other important business done.

An informal dinner for members of the Society and invited guests will be had in the evening.

A circular has been sent to members embodying this announcement, and asking each to state his preference as to time and place of the Ninth Annual Convention, say whether he will be present at the Annual Meeting, and if he will join in the dinner proposed. Members who have not responded, are requested to promptly forward replies to the Secretary.

PAPERS ON ENGINEERING SUBJECTS, giving results of practice, or in discussion of pertinent theoretical questions, are desired from members of the Society; their comments (whether or not present at meetings of the Society), upon papers published in Transactions, are solicited, and they are urged to contribute from note-books and other similar records, whatever may bear upon the subjects considered, or refer to other practical topics. A list of subjects relating to the practice of engineering and its connection with kindred art and public affairs, on which papers are desired, may be found on page 51, vol. I.

ILLUSTRATIONS OF PAPERS presented for publication should be distinctly drawn in *broad, sharp* lines, upon *white, smooth* (not "egg" or enameled) paper, with perfectly (not glossy or grey) *black* ink, to a scale twice or thrice greater than the print is to be; which in no case should require folding in more than one direction, (*i. e.*, the depth of plate, as inserted in Transactions, should not exceed 9 inches). Shades are to be produced by variations in size and spacing of *black* lines; no brush work or colors are admissible. Unless figures and letters can be *well* put in, simply pencil them, leaving the engraver to insert them in the plate. Always put a scale upon each drawing.

EXTRA COPIES.—A member may order 25 copies without charge, and as many more as desired at cost of paper and presswork, of any paper he contributes, by giving notice to the Secretary of the number required—*before* the paper is printed.

DONATIONS TO THE LIBRARY.—Members and others are asked to contribute regularly to the library of the Society, copies of government, municipal, railway, canal and other reports, specifications, profiles, maps, photographs and like matter, making up the record of engineering operations for the past or present, and to inform the Secretary where such may be had. Duplicate copies are desired, for transmission to foreign societies in return for works collected and sent to this library by them; also for exchange with members and others who wish complete sets referring to particular subjects. In order to gather material now considered but of little value, but of great future importance in the history of the public works of this country and a comparison of their economical results, donations are solicited of old reports or pamphlets, which in any way refer to construction or operation.

PHOTOGRAPHS OF MEMBERS.—By resolution of the Society, each member has been requested to furnish two photographs of himself, of the usual card size, as a means of promoting social recognition and intercourse. Those who have not complied with this request are specially asked to aid in making the collection complete, by speedily forwarding their photographs, endorsed with autograph and date.

THE ROOMS OF THE SOCIETY are on the south-east corner of Broadway and Twenty-third street, nearly opposite Fifth Avenue Hotel, and overlooking Madison square; entrance, 4 East Twenty-third street. Members—particularly those from out of town—are invited to make these rooms their headquarters. Appointments with other parties may be kept here, and for such and similar personal matters a private room may be had.

CARD TO MEMBERS.—The following is from a circular issued December 10th, 1872.

"The Society should be of real and positive benefit to each member; that this in one way may result, the Secretary will endeavor to obtain experimental knowledge from experienced members, upon matters of practice, for those who request it; examine in the public libraries authorities upon special topics, select books, instruments and similar 'material' for an engineer's equipment, and to execute other commissions within his province, of a professional character. Those seeking engagement and those requiring engineering service are desired to communicate to him the particulars, that such may be brought together; and generally, all interested are urged to aid in rendering the offices of the Society a bureau of professional information to its members."

Members thus commanding the Secretary are requested to state explicitly what is required, and he will endeavor to execute their commissions with reasonable promptitude, *without charge.*

LIST OF MEMBERS.

ADDITIONS.

Date of Election.

BARNARD, AUGUSTUS P.....As't U. S. Civil Engineer, 28 West 20th street, New York.....April 5, 1876.

BRUNER, DANIEL P. [J.]...As't Eng. P. R. R., Harrisburg, Pa..Sept. 6, "

DRESSER, GEORGE W.....42 Pine street, New York.....July 5, "

GLASKIN, EDWIN F. [J.]....73 Amherst road, Hackney, London, England.....April 5, "

HAMPTON, FREDERICK T....Box 147, Chattanooga, Tenn.... Feb. 3, 1875

KENNEDY, JAMES C. [J.]..As't Eng., Toronto Water Works, Toronto, Can.....Sept. 6, "

WHITLOCK, FRANK. W. [J.].As't Eng., Boston Water Works, South Framingham, Mass.....Oct. 4, "

CHANGES AND CORRECTIONS.

BISSELL, H.....Care T. P. & W. R'y, Peoria, Ill.

COOKE, ROBERT L.....Div. Eng. Dep't Public Parks, 64th street & 5th Av., New York.

COOPER, THEODORE.....Care Henry Flad, 600 Olive st., St. Louis, Mo.

DICKINSON, POMEROY P.....79 Cedar st., New York.

DU BOIS, EDWARD C.....137 Calle Coca, Lima, Peru.

FISK, ALBERT.....526 Broadway, Louisville, Ky.

FLINT, EDWARD A.....Mollendo, Peru.

FORD, ARTHUR L.....Care Am. Soc. Civil Eng's, New York.

HALL, G. THOMAS.....Whitehall, N. Y.

JOHNSON, J. HOWARD.....Res. Eng. J. & C, R'y, Mollendo, Peru.

KATTE, WALTER.....Treas. St. L. & N. R'y, St. Louis, Mo.

KIMBERLY, MOSES.....Res. Eng. M. K. & T. R. R. Sedalia, Mo.

SARGENT, JOHN H.....249 Pearl st., Cleveland, O.

SELLERS, COLMAN.....3301 Baring st., Philadelphia, Pa.

SHREVE, SAMUEL H.....Morristown, N. J.

STAATS, ROBERT P.....Ass't Eng. N. Y. State Canals, Rochester, N. Y.

DECEASED.

WILLIAMS, WILLIAM [F.]...Late of Buffalo, N. Y.....Sept. 10, 1876.

American Society of Civil Engineers.

INCORPORATED 1852.

PROCEEDINGS.

Vol. II, November, 1876.

MINUTES OF MEETINGS.

(Abstract of such, as may be of general interest to members.)

OF THE SOCIETY.

OCTOBER 18TH, 1876.—A stated meeting was held at 8 o'clock P. M.; a paper by John B. Jervis, C. E., of Rome, N. Y. "Memoirs of American Engineering" was read, and briefly discussed. The remainder of the session was spent in conversation.

NOVEMBER 1ST, 1876.—The Twenty-fourth Annual Meeting was called to order at 10½ o'clock A. M., President Greene in the chair; the following were present during the session:—Henry F. Walling, of Boston, and Nathan H. Whitten, of Holyoke, Mass.; Gouverneur K. Warren, of Newport, R. I.; Theodore G. Ellis, of Hartford and Nelson J. Welton, of Waterbury, Conn.; Charles H. Fisher, of Albany; William J. McAlpine, of Babylon; Thomas P. Kinsley and Charles C. Martin, of Brooklyn; James C. Aldrich, Leonard F. Beckwith, Charles Bender, Henry D. Blunden, Alfred P. Boller, Richard H. Buel, Benjamin S. Church, Francis Collingwood, J. James R. Croes, G. Warren Dresser, Charles K. Graham, William H. Grant, Charles M. Harris, Alexander L. Holley, Gabriel Leverich, Thomas J. Long, Charles Macdonald, William W. Maclay, Charles L. McAlpine, George S. Morison, James O. Morse, Willard A. Nichols, Edward P. North, W. Milnor Roberts, John Schuyler, Julius H. Streidinger, Henry W. Stuckle, Stevenson Towle, William E. Worthen, Edgar B. Van Winkle and Edmund Yardley of New York; Charles E. Fogg, of Poughkeepsie; William H. Searles, of Rochester and H. Wadsworth Clarke, of Syracuse, N. Y.; Robert H. Thurston, of Hoboken; Lebbeus B. Ward, of Jersey City; Martin Coryell, of Lambertville and Samuel H. Shreve, of Morristown, N. J.; William P. Shinn, of Pittsburgh, Pa.; Charles Latimer, of Cleveland, O.; Mendez Cohen, of Baltimore, Md., and Elmir L. Corthell, of Port Eads, La.

The Annual Report of the Board of Direction on the affairs, and of the Treasurer on the finances, of the Society were read and accepted.

The vote on admission to membership was canvassed, and the following were declared elected :—Member, Robert E. Pettit, of Philadelphia, Pa., and Junior, Horace E. Stevens, of St. Paul, Minn.

The Society proceeded to elect officers for the ensuing year; ballots were taken, and the following declared elected : George S. Greene, President ; Alexander L. Holley and Theodore G. Ellis, Vice-Presidents ; Gabriel Leverich, Secretary ; John Bogart, Treasurer ; J. James R. Croes, W. Milnor Roberts, William H. Paine, Matthias N. Forney and James O. Morse, Directors.

The President, for the Board of Censors to award the Norman Medal, made report, that for reasons as stated, no award for the current year had been made[a] ; the report was accepted.

The Secretary made report of circulars received from members, relating to place and time of the next Annual Convention ; communications from Messrs. Charles W. Howell and Caleb G. Forshey[b], were read and remarks made by Mr. Elmir L. Corthell, all of New Orleans, and after discussion it was determined to hold the Ninth Convention of the Society, in that city, April 24th, 25th and 26th, next.

A recess was taken and the meeting called to order at 2 o'clock P. M.

Reports of committees were presented, and accepted as follows :— On "Tests of American Iron and Steel[c]," William Sooy Smith, Chairman ; on "Gauging of Streams," Theodore G. Ellis, Chairman ; on "Resistances of Railway Trains[d]," and on "Uniform Accounts and Returns of Railroad Companies[e]," William P. Shinn, Chairman ; also of the "Centennial Commission of the Society[f]," Theodore G. Ellis, Chairman, and of "Committee on Finance," W. Milnor Roberts, Chairman.

On motion, the Committees on "Tests of American Iron and Steel," and on "Resistances of Railway Trains," were continued ; the Committee on "Gauging of Streams" was also continued and J. James R. Croes added thereto as Chairman, and William P. Shinn, Octave Chanute and Frederick de Funiak were appointed a Committee on "Uniform Accounts and Returns of Railroad Companies[g]."

Recommendations made in the Annual Report of the Board of Direction were taken up, and the following were referred to the Board, with instructions to report to the Society what action is necessary in each case.

First. Whether at end of the current calendar year, the two publications of the Society, "Transactions," and "Proceedings," may "not be merged into one, with otherwise substantially the present arrangement as to form of page and style of print[h]."

Second. What provision should be made in the "Society laws whereby it may get rid of an unworthy member[i]."

Third. Should not the number of votes necessary to exclude a candidate from membership be increased, either in proportion to the number of votes cast or of Members at the time in the Society.

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[a] Page 154. [b] Page 164. [c] Page 155. [d] A verbal report. [e] Page 157. [f] Page 156.
[g] The other two members of former Committee were unable to serve. [h] Page 142. [i] Page 151.

W. Milnor Roberts presented a diagram showing operations at "Head of Passes," mouth of the Mississippi river, up to October 22d, and gave a descriptive account, which was briefly discussed.

NOVEMBER 15th, 1876.—A stated meeting was held at 8 o'clock P. M.: a paper by Max J. Becker, C. E., of Columbus, O., on the "Reconstruction and Enlargement of Cork River Tunnel" was read, and discussion followed; the remainder of the session was spent in conversation.

OF THE BOARD OF DIRECTION.

AUGUST 16TH, 1876.*—An adjourned meeting was held at 4 o'clock P.M.

The Secretary stated that at the Eighth Annual Convention, reports of the Committee on "Change of the Society's Rooms," and on "National Recognition of the Society," were presented and referred to the Board with power; and that the following resolutions were, under the By-Laws relating to the appointment of special committees also referred to the Board:—

"Resolved, that the American Society of Civil Engineers will further, by all legitimate means, the adoption of the metric standards in the office of Weights and Measures at Washington, as the sole authorized standards of weights and measures in the United States; that the Chair appoint a committee of five, to report to the Society a form of memorial to Congress in furtherance of the object expressed; and that the foregoing be submitted to the Society and voted on by letter ballot.

"Resolved, that a committee of five be appointed by the Chair, to consider the subject of uniform accounts and returns of railroad companies."

The same were considered, and John Bogart, W. Milnor Roberts, Francis Collingwood and G. Leverich were appointed a Committee on "Quarters for the Society," and William P. Shinn, Octave Chanute, Charles Paine, Mendez Cohen and Frederick de Funiac, a Committee on "Uniform Accounts and Returns of Railroad Companies."

OCTOBER 18th and 25th, 1876.—An adjourned meeting for preparation of the Annual Report of the Board "on the affairs of the Society," to be presented at the Annual Meeting, was held each date.

NOVEMBER 4TH, 1876.—A meeting of the Board, under Art. VII of the Constitution, was held at 7½ o'clock, P. M. The business in order,—appointment of standing committees on Library and on Finance, was referred to the President.†

* Omitted in course.

† The President subsequently appointed Committee on Finance, W. Milnor Roberts, Theodore G. Ellis and William H. Paine; and Committee on Library, J. James R. Croes, John Bogart and Matthias N. Forney.

Special Committees were appointed as follows: on "Revision of the Constitution," the President, W. Milnor Roberts and John Bogart; on "Change of Name of the Society," the President, Chairman of Committee on Finance and the Secretary; on "Nominations and Proposals for Membership," and on "Fitting up and Furnishing the Society's Rooms," the President, Secretary and Treasurer; on "Quarters for the Society," John Bogart, W. Milnor Roberts, Francis Collingwood, Gabriel Leverich and William E. Worthen; and on "Officers' Receptions," Gabriel Leverich, John Bogart, and Francis Collingwood.

THE

ANNUAL REPORT OF THE BOARD OF DIRECTION,

FOR YEAR 1875–6.

ACCEPTED NOVEMBER 1ST, 1876.

The Board of Direction, in compliance with Art. XII of the Constitution, herewith presents a "Report on the affairs of the Society, embracing the Report of the Treasurer" for the year ending October 31st:

On November 3d last, the membership was—

Honorary Members resident,	2	non-resident,	4	total			6
Corresponding "		"	1	"			1
Members "	105	"	266	"		371	
Associates "	5	"	13	"		18	
Juniors "	9	"	27	"		36	
Making "	121	"	311	"			425
Fellows, 72—of whom 11 are Members and 1 Honorary Member—leaving							60
Total then connected with the Society							492

To-day the membership is—

Honorary Members resident,	2	non-resident,	4	total			6
Corresponding "		"	3	"			3
Members resident	113	"	304	"		417	
Associates "	5	"	11	"		16	
Juniors "	7	"	44	"		51	
Making "	127	"	366	"			484
Fellows, 70—of whom 10 are Members, and 1 Honorary Member—leaving							59
Total now connected with the Society							552
On November 3d last, the number of proposals and applicants for admission to the Society was							23
The number of proposals and applicants during the year was							70
Total number of proposals							93

Of this number 2 were elected as Corresponding Members, 50 as Members, 20 as Juniors and 2 as Fellows; 4 were laid on the table or withdrawn, and 6 are pending.

Of those who were elected, 1 Junior was proposed as Member; 4 Members elected before November 3d last, and 2 Corresponding Members, 40 Members, 18 Juniors and 1 Fellow elected during the year, have qualified.

The increase during the year has been—

Corresponding members		2
Members admitted, 44—2 Associates and 2 Juniors became Members, 48—less 1 deceased and 1 resigned		46
Juniors, 18—less 2 became Members and 1 deceased		15
		63
Deduct—2 Associates who became Members	2	
2 Fellows deceased, less 1 admitted	1	
	3	
Total increase		60

21 meetings of the Society were held during the year, one of which was the Eighth Annual Convention, and one—a stated meeting—held as an "officers' reception;" 10 were "regular" meetings, at which ballots for members were canvassed and other business done, and 9 were "stated" meetings when papers were read and discussions had upon engineering subjects and generally time given for conversation.

Since removal to these rooms, May 1875, all meetings of the Society held here, except the Annual Meeting, have been in the evening. Although this is not convenient for some residents who reside most remote from this point, it generally accommodates a larger number than if the meetings were held during the day.

The meeting on December 15th was held as a "social and conversational meeting or officers' reception," at which a member gave a colloquial lecture and discussion followed; refreshments were served, and the intervals were spent in conversation.

11 stated and 3 special meetings of the Board were held during the year, generally for examination into the qualifications of candidates for membership, the application of the Society's funds and similar general business of the association.

The Eighth Annual Convention was held in Philadelphia, June 13th, 14th and 15th, accompanied by brief excursions to a few points of interest in the city, and a trip over the "New York & Philadelphia New Line" to New York and return. Attending members had also opportunity to visit the International Exhibition. Three sessions were held—one a business session, under addition to Section 1, By-laws, concerning Conventions, adopted February 2d,—minutes of which have appeared in Proceedings. The attendance of engineers, members and others, from here and abroad, was greater than at any other meeting of the Society.

As at the preceding Convention, under rules adopted December 2d, 1874, a list of topics to be considered with reference as to Papers and Reports treating thereon, published in Transactions the preceding year, was duly submitted to members: the topics were called in regular order, and but short papers read. Discussions then had, are now being printed in Transactions; this method is no longer an experiment and experience with it seems to warrant a continuance of the practice.

Papers were presented to the Society during the year as follows:

Description and Results of hydraulic Experiments with large apertures, at Holyoke, Massachusetts, in 1874. Theodore G. Ellis.
Efficiency of Steam Vacuum Pumps. J. Foster Flagg.
Note on the Resistances of Materials. Robert H. Thurston.
Verrugas Bridge and the Method of its Erection. L. Lefferts Buck.
The Portage Bridge. George S. Morison.
The practical Determination of Strains in the braced Arch. A. Jay DuBois.
Discharge of Water in Jets and Long Mains. Galen W. Pearsons.
Notes and Suggestions on the Croton Water Works and Supply for the Future. Benjamin S. Church.
Theory of continuous Girders in Relation to Economy in Bridge Building. Charles Bender.
Note on the Resistance of Materials, as affected by Flow and by Rapidity of Distortion. Robert H. Thurston.
Fac-Simile Telegraphy. Robert L. Cooke.
A Water Conduit under Pressure. John T. Fanning.
History of the Lehigh Coal & Navigation Co. and its Works. Robert L. Cooke.
Determination of the Resistance of Railway Trains. Robert H. Thurston.
Reconstruction and Enlargement of Cork River Tunnel. Max. J. Becker.
Memoirs of American Engineering. John B. Jervis.
Dams for Reservoirs—shall they be of Earth or Masonry? William J. McAlpine.
Connected segmental Marine Boilers, a Demonstration of the Principles of their Construction. Charles E. Emery.
Railroad Accounts and Returns. William P. Shinn.
Qualities of Iron and Steel. William Metcalf.
A cheap Transfer Table. William P. Shinn.
Gauging of Streams, a special Case. David M. Greene.
Cut-Offs on the Mississippi River, their Effects on the Channel, above and below. Caleb G. Forshey.
Laying Masonry in cold Weather. J. Dutton Steele.
Compressed Air Locomotives. J. Dutton Steele.
Principles of tidal Harbor Improvements, as applied at Wilmington, Cal. Clinton B. Sears.

Reports were made to the Society during the same time, as follows:

Annual Report of the Board of Direction, on the Affairs of the Society, for Year ending November 3d, 1876.
Award of the Normal Medal. Julius W. Adams, Chairman.
On Tests of American Iron and Steel (2 reports). W. Sooy Smith, Chairman.
On Change of the Society's Rooms (2 reports). John Bogart, Chairman.
On Time and Place of the Eighth Annual Convention. G. Leverich, Chairman.
On Organization of a Mutual Benefit Society. William E. Worthen, Chairman.
On Policy of the Society. Alexander L. Holley, Chairman.
On Securing a National Recognition of the Society. W. Milnor Roberts (for Committee).
On Uniform Gauging of Streams in Connection with Observations of Rainfall; and
On Failure of Dam at Worcester, Mass. Theodore G. Ellis, Chairman.
On Form, Weight, Life and Manufacture of Rails. Ashbel Welch, Chairman.
On Nomenclature and Classification of Masonry. J. James R. Croes, Chairman.
On Resistances of Railway Trains. William P. Shinn, Chairman.
On Technical Education. Henry R. Worthington, Chairman.

Discussions were had on many of these papers and reports when read before the Society; also on the following subjects:

Consumption and Waste of Water.
Design and Erection of the Exposition Buildings.
Docks and Wharves.
Engineering Questions considered in the Location and Construction of the New York & Erie R. R.
Improvement of the Mouths of the Mississippi.
Levees as a System of reclaiming Low Lands.

Metric System of Weights and Measures.
Overland Telegraph to Europe.
Professional Intercommunication.
Progress of the Jetties at South Pass of the Mississippi.
Waves of Translation that Emanate from a submerged Orifice.

Many of these papers, reports and discussions have been published in the Journal for the current year; also these papers presented last year:

Notes on the Improvement of the Mouth of the Mississippi. W. Milnor Roberts.
Levees as a System of reclaiming Low Lands. George W. R. Bayley.

Referring to the list of papers presented to the Society which were unpublished at the date of last report; of these, the following were published during the past year:

Experiments on the tensile Strength of Steel Wire. Thomas C. Clarke.
Levees as a System of reclaiming Low Lands. George W. R. Bayley.

The following was omitted from the list:

Construction of a River Wall at Foot of Canal street, N. R. William A. Radenhurst and John D. Van Buren, Jr. June 10th, 1875;

And the following presented and not published during this year, are to be added:

Efficiency of Steam Vacuum Pumps. J. Foster Flagg.....November 3, 1875.
The practical Determination of Strains in the braced Arch. A. Jay Du Bois.....November 30, 1875.
Memoirs of American Engineering. John B. Jervis..... February 1, 1876.
Fac-Simile Telegraphy. Robert L. Cooke..... March 27, 1876.
A Water Conduit under Pressure. John T. Fanning..... April 5, 1876.
Reconstruction and Enlargement of Cork River Tunnel. Max J. Becker. April 15, 1876.
History of the Lehigh Coal & Navigation Co. and its Works. Robert L. Cooke..... April 19, 1876.
Connected segmental Marine Boilers, a Demonstration of the Principles of their Construction. Charles E. Emery..... May 17, 1876.
A cheap Transfer Table. William P. Shinn..... June 5, 1876.
Principles of tidal Harbor Improvement, as applied at Wilmington, Cal. Clinton B. Sears..... July 27, 1876.

In addition to these are several reports of Committees, upon a number of subjects, which still are unpublished.

During the year the Journal of the Society has been published monthly at a cost, for 1 000 copies each month, substantially as follows:

For printing.....		$2 512 05	
illustrating.....		393 25	
copyright.....		6 00	
Total gross cost for 732 pages.....			$2 911 30
Deduct for 76 " advertisements.....			712 33
Net cost for..... 656 "			$2 198 97

or $3.35 per page, which it will be seen is within the original estimate.*

These 656 pages do not include 17 sheets of plates and 1 "inset" of tabular matter equivalent to about 100 additional pages. For the year, "Transactions" contain 15 papers covering 252 pages, and discussions covering 162 pages. There are, 1 sheet of tabular matter, 12 folding and 1 full page plates and 41 wood-cuts; also 5 folding plates in "Proceedings."

* See Proceedings, Vol. I, page 307.

The "Proceedings" contain in addition to the reports mentioned—

Announcements of Meetings to be held, Topics discussed, &c.
Book Notes.
List of Additions to Library and Museum.
Lists of Members, with Addresses, Changes and Corrections.
List of new engineering and technological Books.
Memoirs of deceased Members.
Notes and Memoranda. Short articles on—
- American Bridge Construction.
- " Engineering at the Centennial.
- Bridges and Bridge Foundations.
- Centennial Commission of the Society.
- Committee Work.
- Compressed Air Locomotive.
- Concerning Conventions.
- Dams for Reservoirs.
- Determination of the Resistances of Railroad Trains.
- Discharge of Water from Jets and in long Mains.
- Fall of an Iron Bridge.
- Jetties at South Pass of the Mississippi River.
- Laying Masonry in cold Weather.
- Metric System of Weights and Measures.
- Selecting Papers to be published.
- Sketches of engineering Exhibits at the International Exposition.
- Tests of American Iron and Steel.

Proceedings of the Board of Direction and of the Society.
Statement of the Finances of the Society.

Vol. IV of Transactions and Vol. I of Proceedings closed with the December number, and an Index and Title Page for each has been issued. The Index for the latter has been made full and specific, with the view that members who have not a file of Proceedings may thereby know what topics are treated therein. A similar topical index of the first five volumes of Transactions is in preparation, to be issued probably with December number. Henceforth it is proposed to begin and close the volumes with the calendar year.

A List of Members of the Society, with their addresses, was issued May 20th.

When it was determined to print papers and other matter of interest to members, monthly, the present form of publication was adopted; namely, papers and discussions thereon to appear as Transactions; minutes and announcements of meetings, lists of new scientific and engineering works and of donations to the library and museum, reports from the Society to members and similar matter, to appear as Proceedings; to be arranged and paged separately although issued under one cover. This involves an increased expense, and causes much confusion; it is suggested whether, at the end of the current calendar year, when volumes of both issues will close, the two publications should not be merged into one, with otherwise substantially the present arrangement as to form of page and style of print.

By the courtesy of Mr. William E. Worthen, of the committee of experts, Reports on the trial of Duty and Capacity of Pumping Engines of the

"Milwaukee Water Works" and of the "Lawrence Water Works," have been issued to members as Appendixes of the Journal. Similarly by the courtesy of Mr. Frederick Brooks, the "Metric System of Weights and Measures," a communication to members, was sent out. It is hoped that these examples will be followed, and reports of engineering works or operations thus distributed among those of the profession who value and will preserve them.

During the past year, the Library has continued to increase, mostly as before, by the contributions of members and others interested in its growth. There have been added in that time

Books bound	274
Books unbound and pamphlets	488
Manuscripts (bound volume)	1
Maps, plans, drawings and charts	66
Photographs and engravings	52
Models and specimens	12

These do not include magazines and papers contributed to the Society by publishers or received in exchange for the Journal, as follows:

Annales des Ponts et Chaussees	Quarterly,	Paris.
Deutsche Bauzeitung	Semi-Weekly,	Berlin.
Engineering News	Weekly,	Chicago.
Engineering	"	London.
Iron	"	"
Journal of the American Iron and Steel Association	"	Philadelphia.
Journal of the Society of Arts	"	London.
Manufacturer and Iron World	"	Pittsburgh.
Monthly Record of scientific Literature	Monthly,	New York.
Official Gazette of the United States Patent Office	Weekly,	Washington.
Railroad Gazette	"	New York.
Stummer's Ingenieur	"	Vienna.
The American Architect and Building News	"	Boston.
American Chemist	Monthly,	New York.
Army and Navy Journal	Weekly,	"
Builder	"	London.
Building News and Engineering Journal	"	"
Chicago Railway Review	"	Chicago.
Commissioners of Patents Journal	Semi-Weekly.	London.
Engineer	Weekly,	"
Engineering and Mining Journal	"	New York.
Hydraulic Engineer	Monthly,	Cincinnati.
Iron Age	Weekly,	New York.
Journal of the Franklin Institute	Monthly,	Philadelphia.
Manufacturer and Builder	"	New York.
Polytechnic Review	Weekly,	Philadelphia.
Railway Age	"	Chicago.
Railway World	"	Philadelphia.
Telegraphic Journal and Electrical Review	Semi-Monthly,	London.
Van Nostrand's Eclectic Engineering Magazine	Monthly,	New York.

The following are subscribed for:

Allgemeine Bibliographie fur Deutschland	Weekly,	Leipzig.
Bibliographie de la France	"	Paris.
Bookseller	Monthly,	London,
Publishers' Weekly	Weekly,	New York.
Scientific American, with Supplement	"	"
United States Official Postal Guide	Quarterly,	Boston.

The Society has received during the year, in exchange for its Journal, official publications, in sets more or less complete, of the following associations :

American Institute of Architects.....New York.
American Institute of Mining Engineers.....Philadelphia.
Architecten und Ingenieur Verein Zu Hanover.....Hanover.
Associacao dos Engenueiros Civis Portuguezes.....Lisbon.
British Patent Office.....London.
Boston Public Library.....Boston.
Civil Engineers' Club of the Northwest.....Chicago.
Department of Agriculture.....Washington.
Engineers' Club of St. Louis.....St. Louis.
Essayons' Club, Engineer Corps, U. S. A.....Willet's Point.
Institution of Civil Engineers.....London.
Institution of Engineers and Shipbuilders of Scotland.....Glasgow.
Institution of Mechanical Engineers.....Birmingham.
Institution of Mining and Mechanical Engineers.....Newcastle.
Iron and Steel Institute.....London.
Oesterreicher Ingenieur und Architecten Verein.....Vienna.
Royal United Service Institution.....London.
Sachsischer Ingenieur und Architecten Verein.....Dresden.
Society of Engineers.....London.
Societe des Ingenieurs Civils.....Paris.

The following associations have arranged to exchange with the Society, but their publications are not yet received :

Imperial School at Moscow.....Moscow.
Russian Imperial Technical Society.....St. Petersburg.

Including the Serials received during the year, and making altogether 60 unbound volumes, the present state of the Library is nearly as follows :

Books bound	2 128
Books unbound and pamphlets	3 424
Manuscripts	85
Maps, plans, drawings and charts	685
Photographs and engravings	409
Models and specimens	158

Contributions to the Library and Museum, through the Centennial Commission, also are not included ; such are still in Philadelphia.* These comprise a large and desirable collection of drawings, maps, photographs, models, reports and other books describing and illustrating American engineering; from members of the Society and others residing here, and similar matter relating to European engineering, of which the following is an imperfect list. Upon the close of the Exhibition a complete list of all donations received will be prepared, and proper acknowledgments made.

From the *Austrian Society of Civil Engineers*, Vienna :
The collection now on exhibition in Philadelphia.
From *M. Bartels*, Germany :
Arrangements for the Amelioration of the Condition of the Miners of Prussia.
From *Mr. Beloe*, England :
Photographs.
From the *Chilean Commission :*
The Chilean Country. Vol. I.

From *M. Deby*, Belgium :
Collection of Drawings and Photographs from works and manufactures of "Société Anonyme."
From *Mr. Dredge*, England :
Official Report of Vienna Exposition, 1872, to the English Government. (4 Vols.) Drawings relating thereto. (1 Vol.)
From *M. Fyrnie*, Netherlands :
Collection of Photographs of Engineering Work in the Netherlands.
From the *Italian Commission :*
First Congress of Italian Engineers and Architects at Milan. (Vol. I.)
From *M. Krupp*, Prussia :
Collections of Photographs of Artillery and of Drawings of Railroad Material.
From *M. Lavoinne*, France :
Collection of Drawings from "l'Ecole des Ponts et Chaussées" in France.
From *M. Malheiro*, Portugal :
Collection of Maps of Portugal.
From *M. Schaar*, Belgium :
Railroads of the State, Transportation, Telegraphy, Marine affairs, etc. Report to the Legislative Chambers by the Minister of Public Works. (Vol. I.)
From *M. Van der Hoewen*, Russia :
Map of St. Petersburg and Moscow Railroad.

It will be seen that the Library of the Society is growing steadily in volumes, and in value as a source of information to members and others seeking knowledge of engineering theory and practice. Its usefulness will be greatly increased by a complete catalogue of subjects and authors and an arrangement whereby any work required may be readily found. Such a catalogue has been for some time in preparation and now is nearly complete. The plan adopted is after what is known as the card system : the general and particular title of the work, author's name, description of style, donor's name (if the work is donated), shelf and case numbers are for each book, treatise, or author, written upon a card; these cards are to be arranged alphabetically in suitable cases. Under such a system, additions or changes in the catalogue may be easily and promptly made, and the fullest information given regarding any contents of the Library.

The Library contains many volumes of papers, journals, and other serial works, sets of reports, pamphlets, and the like, more or less complete, which should be bound, to preserve them as well as to fit them for ready use. Being almost entirely a collection of works donated by members and others, it necessarily lacks important books of reference more or less required by members who here investigate any special subject. The Board, therefore, would again call attention to a suggestion in a preceding report—"Whether a certain specific proportion of the Society's income should not be set apart and appropriated to the increase and maintenance of the Library; to bind in substantial style reports, pamphlets, serials, and other works requiring it, and to purchase standard books of reference."

The need and scope of an American engineering library has been, to some extent, set forth in a report on "Founding an Engineering Library and Museum," presented April 25th, 1875, to which reference is here

made.* With care on the part of each member of the Society, to furnish one or more copies of each treatise, report, map, or other record of engineering operations, present or past, there will soon be in these rooms much that otherwise could not be had, and which will become invaluable.

There are in the Library many duplicate copies ; it is proposed that when the catalogue and arrangement are finished, a list of these as well as of numbers or volumes required to complete sets in the library shall be sent to members, and to ask exchange of one for the other, page for page, or otherwise.

The use of a library of the Society will be restricted to resident members and non-residents, who occasionally visit New York, unless means be taken, under necessary restrictions, to send works to those who desire it, or here to make examinations for them. That by some such plan it is feasible to render a library of this character, of great value to members remote from the centres of literary and professional knowledge, is believed, and full consideration of the matter by the Society with a view to elaborate such a plan, is recommended.

Thanks of the Society are due to members by whose contributions this Library has been formed ; formal acknowledgments of their donations appear regular in Proceedings, and they will be held in grateful remembrance whenever the works they have supplied are referred to by seekers for knowledge.

The Board of Censors to award the Norman Medal made report at the last Annual Meeting, whereby a paper entitled "Descriptions and Results of Hydraulic Experiments with large Apertures, at Holyoke, Mass., in 1874," by Theodore G. Ellis, was declared entitled to the medal for year 1874–5, and it was formally presented, December 1st.

Further consideration of the matter and a year's additional experience, causes this Board to call again attention to "the desirability of a change in the conditions of award of this medal, so that papers read before the Society during the year, as well as those specially prepared for competition, may be eligible for the prize ;" as referred to in last report.†

Committees at the beginning of the past Society year, charged with the examination of special professional subjects, were as follows :

On "Tests of American Iron and Steel," appointed June 6th, 1872, W. Sooy Smith, Chairman. This Committee made report at the Annual Meeting and the Annual Convention, and was continued.

On the "Form, Weight, Manufacture, and Life of Rails," appointed May 22d, 1873, Ashbel Welch, Chairman. This Committee made final report at the Annual Convention, and was discharged.

On the "Means of Averting Bridge Accidents," appointed May 22d, 1873, James B. Eads, Chairman ; and on "Railway Signals," appointed June 16th, 1874, James Dutton Steele, Chairman. It was stated at the

*Proceedings. Vol. I, page 310. †Do., page 224.

Annual Convention that since reports were made, and during the year preceding, these Committees had taken no action, and they were discharged.

Committees for this purpose were appointed during the year, as follows:

On the "Nomenclature and Classification of Masonry," J. James R. Croes, Chairman, ordered December 1st, "to investigate the varieties of nomenclature and classification used in different parts of the United States, to designate the several kinds of stone-cutting and masonry and the tools employed in such work, and also the corresponding terms used by French, German and English writers on these subjects; and to inquire into the possibility of securing uniformity of practice in such nomenclature and classification." This Committee made report at the Annual Convention, and was continued.

On the "Gauging of Streams," Theodore G. Ellis, Chairman, ordered December 1st, "to inquire into the feasibility of establishing a uniform method of gauging of streams and rivers of known watershed, in connection with observations of rainfall," and "empowered to request the co-operation of the Smithsonian Institution and the Franklin Institute in the matter." This Committee made report at the Annual Convention, and was continued.

On "American Engineering at the Centennial Exhibition," Theodore G. Ellis, Chairman, appointed December 1st, "to prepare memoirs and to arrange for the exhibition of plans, models, and specimens showing the progress in this country, of engineering in its several branches." This Committee was increased in number, and under the name of the "Centennial Commission of the American Society of Civil Engineers," entered upon its work, which elsewhere is referred to.

On "Technical Education," Henry R. Worthington, Chairman, appointed March 1st, "to confer with a Committee of the American Institute of Mining Engineers," "to present the subject of technical education for discussion by the two associations, at the Centennial." This Committee made report at the Annual Convention, and the discussion was had in Hall of Franklin Institute, June 19th and 20th.

On "Failure of the Dam at Worcester, Mass.," Theodore G. Ellis, Chairman, ordered May 3d, to examine and report thereon. This Committee reported at the Annual Convention, and was discharged.

On "Resistances of Railway Trains," William P. Shinn, Chairman, ordered May 3d, "to examine and report thereon." This Committee reported at the Annual Convention, and was continued.

On "Uniform Accounts and Returns of Railroad Companies," William P. Shinn, Chairman, appointed August 16th, to consider the subject. A report from this Committee is expected at the Annual Meeting.

The following Committees of the Society appointed for special, though not strictly professional work, are here referred to.

On a "Plan for the Increase, Maintenance and Preservation of an engineering Library and Museum," appointed July 2d, 1873, Julius W. Adams, Chairman. At the Annual Convention, this Committee, not having made report since May 12th, 1875, was discharged.

On "Securing a national Recognition of the Society by federal Charter or otherwise," appointed June 3d, 1874, George S. Greene, Chairman. A report was presented at the Annual Convention, which was referred to this Board, and the Committee was discharged.

On "Organizing a Mutual Benefit Society," William E. Worthen, Chairman, appointed October 20th, 1875. This Committee made report at the Annual Meeting; its duties ceased January 5th.

On "Policy of the Society," Alexander L. Holley, Chairman, appointed June 8th, 1875. This Committee made report at the Annual Meeting, and its duties ceased.

At the meeting, April 7th, 1875, the following was made an order of business at the Seventh Annual Convention:

Resolved, That a Committee be appointed to investigate the feasibility of organizing the Society—as a whole or by voluntary membership—as a Mutual Benefit Society to aid and benefit the families of deceased members.

The resolution was then considered and adopted; a Committee was subsequently appointed, William E. Worthen, Chairman, which reported at the Annual Meeting, and in compliance with its recommendation, each Member and Junior was asked by circular whether he would become a member of a "Civil Engineers' Insurance League," formed on a basis set forth in the report. The replies were canvassed January 5th, and it was announced that 59 would join the League, and 62 would not. As the Committee was "of the opinion that the organization of such an association should not be made" with less than 100 persons, no further action was taken.

With a view to aid in a proper representation of American engineering progress and practice at the Centennial Exposition, a Committee, Theodore G. Ellis, Chairman, was appointed, at the Annual Meeting, to consider the subject and take such steps as might seem desirable. Others were added to the Committee, and the Centennial Commission of the American Society of Civil Engineers, constituted.

A plan was determined whereby—*first*, engineers who were or had been in charge of important, novel or interesting works, railroad, canal and other public corporations, and especially builders or manufacturers willing to make their works known, were urged to present such specimens, models, plans, photographs and descriptions as would give to visitors at the Exposition an adequate and correct idea of engineering progress and practice in this country, and to exhibit the same either in groups or under the general classification; and *second*, a secretary was in attendance during the Exposition, to give such detailed information, as by an inspection of the models, plans, &c., visitors were led to ask for.

Sub-committees were appointed on Railroads and Rolling Stock; Bridges and Bridge Construction; Water Works; River and Harbor Improvements; Canals and inland Navigation; Hydraulic Motors and Machines; Foundations and Masonry; Surveying, Geodesy and Landscape Engineering; Sewerage and Sanitary Engineering; Light-Houses and Signals; Steam Engineering; Metallurgical Engineering; Gas Engineering; Mechanical Engineering, and Electrical Engineering, on Correspondence and Circulars; Rooms and Representation; Arrangements and Space, and on Finance.

The Commission secured in the Main Building, ample space for an office, with room for the display of maps, drawings, photographs and models, and by courtesy of the American Institute of Mining Engineers, the privileges of an office and meeting-room were had with a similar Commission of that association, at 1100 Girard street.

Steps were also taken to have memoirs prepared for publication, setting forth the progress and present state of the several branches of engineering in this country.

For the expenses of the Commission, $4 100 have been subscribed, mostly by members of the Society, to whom and others who thus contributed to the success of this undertaking, the thanks of the Society are due.

The Board takes especial pleasure in reviewing the work of the Commission, as assisted by members of the Society. While the exhibit of engineering, drawings and models is as complete as could have been expected under the circumstances; the usefulness of the organization to foreign engineers and to the profession at large has been more marked and comprehensive than its promoters anticipated. The gallery of the Commission in the Main Building has been the daily rendezvous of our own members and professional men of other home and foreign societies, and the large collection of drawings has aided their study of American Engineering, while several draftsmen have been almost constantly employed in copying for them the more characteristic designs; and more important still, the organization has been the means of bringing together, by the shortest and most effective methods, inquiring engineers from all parts of the world, and the makers and managers of our machinery and engineering works, by means of letters, personal introductions, directions and data concerning localities, routes, production and character of works.

In this connection, the Board refers with particular gratification to the most useful, harmonious and agreeable co-operation of our Centennial Commission, with that of the similar Commission of the American Institute of Mining Engineers, whose rooms in the city of Philadelphia, with their large collections of maps and periodicals, have been open to all engineers, and in whose weekly *conversationes*, our members have been invited to take as conspicuous a part as their own. The joint action of these two Commissions has been of greater service to foreign guests and to the

members of the respective societies than their independent action could have been, and it has during the meetings, receptions and excursions of the two societies in June last and on numerous occasions throughout the period of the exhibition, promoted a very large acquaintance and a most kindly feeling among their respective members. It is reasonable and gratifying to believe that the value of this co-operation will not terminate with the Centennial year, but that its results, while in no way interfering with the independence of either society, will continue to be a permanent benefit to both and to the profession at large.

The present location of the Society's rooms seems to be generally acceptable to members ; the lease under which they are held will, however, expire April 30th next, and meanwhile the large quantity of valuable material accumulated by the Centennial Commission at the Exposition in Philadelphia, is to be cared for, either by storing in bulk, or by arranging so that observers may examine and use it. As indicated in reports of the committees formerly charged with this matter, it has been proposed to co-operate with kindred organizations, and either by purchase, or lease on satisfactory terms, thereby secure permanent quarters, specially fitted for the use required and which shall be reasonably safe from fire. A committee, consisting of members of several scientific associations in this city, has considered this matter some time, and another committee of the Society, on permanent quarters, was appointed August 16th.

These rooms were kept open week day evenings at irregular intervals, for a considerable part of the time, since they were first occupied, with a view to test how far they would be used in a part of the day, which to most members, is of more leisure than any other, and also to foster and increase use at such time. Experience thus gained, has not been favorable to the effort, and for some months the rooms have been closed during the evening, except when Society or Committee meetings were held.

If in any way these rooms could be made a place of more frequent resort to members—those who reside in town, as well as those who frequently visit it—one of the prominent objects of the Society, "the encouragement of social intercourse among men of practical science," would be greatly promoted. With this in view, addition to Section I of By-Laws was proposed at the Annual Meeting, and adopted February 2d. It is :—

> The Officers of the Society may give a reception at the Society's rooms on the evenings of the second and fourth Wednesdays of each month, between October and April, for the purpose of informal professional conversation and social intercourse. Regulations concerning refreshments and the invitation of guests, may be made by a committee appointed for the purpose, but shall be without expense to the Society.

Attention is called at this time to this clause and action recommended, whereby it shall be carried into practical effect.

At the Annual Meeting, a communication from a Member was read,* referring to the adoption of the metric system of weights and measures, and proposing that, whether the Society petition Congress to fix a date—say three years hence—when such shall be the legal system, be submitted to vote of members by letter ballot. After discussion, the matter was laid on the table. Further communications on the subject were presented; a copy of one (from Messrs. Brooks, Rice and Herschel, Committee,) was sent to each member, and at the Annual Convention, after discussion, the following was, under By-Laws relating to appointment of special committees on engineering subjects, referred to the Board:—

Resolved, That the American Society of Civil Engineers will further, by all legitimate means, the adoption of the metric standards in the Office of Weights and Measures at Washington, as the sole authorized standard of weights and measures in the United States; that the Chair appoint a committee of five, to report to the Society a form of memorial to Congress in furtherance of the object expressed; and that the foregoing be submitted to the Society and voted on by letter ballot.

At the Annual Meeting, November 4th, 1874, the fee of Fellows was reduced from $250 to $150, and, as before stated, two members of this class have been elected this year. At the last Annual Meeting, the fee of Resident Juniors was increased from $10 to $15. The Board would recommend, that at this time no change in either fees or dues of members, in either class, be made.

In the practice of engineering or among those interested in its advancement, are many of culture and experience not members of the Society, who would confer honor upon it and, as such are admitted, its strength, influence and usefulness will increase; the rate and permanence of this growth—decidedly marked the past year—very much depends upon the individual efforts of members, who are asked to aid in this by presenting the Society and its objects to those known as eligible for admission.

Referring, as in preceding reports, to the conditions of membership in the Society, the Board would again earnestly request attention to what has already been said in regard to the proposal of candidates.†

At the Annual Convention, in business session, reference was made to a clause in Art. XX of the Constitution providing that "in the elections for membership of either class * * * three or more ballots cast in the negative shall exclude," and it was considered whether this number should not be increased; it being urged that the provision was adopted when there were of voting members about one-tenth of the present number. After debate, the matter was laid upon the table: an influential argument against change being, that there is no provision in the Society's laws to get rid of an unworthy member. The Board recommends that proper action be taken to meet this objection.

In considering qualifications of candidates, the question arose, what constitutes a Civil Engineer, as compared with Mining or Mechanical

* Proceedings. Vol. I, page 321. † Page 313.

Engineer, and at meeting of the Board, March 1st, it was referred to a Committee, Alexander L. Holley, Chairman, to report the changes in regard to the matter, which should be made in the organic law of the Society.

This amendment to the By-Laws, recommended by the Board to the Society, December 1st, was, January 5th, referred to the Board for revision, and then was submitted to the Treasurer, for report:—

SECTION.... Annually, on November 1st, all members shall be classed as Resident or Non-Resident, and the Treasurer shall consider those as Resident, who do not on notification, certify to the Secretary before that day, their residence otherwise.

After another year's experience in the use of the Letter Ballot for the election of members, adopted three years ago, the Board has no change in plan or use as thus applied, to suggest.

The system was first applied to other matters in the action of the Society, September 1st, 1875, when, whether Committees on the "Nomenclature of Masonry," and on the "Gauging of Streams," should be appointed, was submitted to Letter Ballot. At the Annual Meeting, a similar vote, referring to organization of a "Civil Engineers' Insurance League," was ordered. January 5th, Section 32 of By-Laws was adopted, applying the system to determining whether special committees to report on engineering subjects shall be authorized, and since, the appointment of Committees on "Failure of the Dam at Worcester, Mass.," on "Resistances of Railway Trains," and on "Uniform Accounts and Returns of Railroad Companies," has been so determined.

The large number of votes cast in this manner at one time, shows the interest that members take in questions thus referred to them concerning the Society, or its affairs, and it may well be considered, whether it would not be wise to adapt the same system to the election of officers of the Society.

Some time since, certificates of membership, printed in three styles—namely, on parchment, on stiff paper, and on bond paper—were prepared. After consideration, the Board determined that such should be issued to members desiring them, the certificate to be numbered in order of date of his qualification, that a record be made of each issue and number, and that a new certificate be issued only on surrender of the old or preceding one. Upon examination, discrepancies in the early records were found which prevented a compliance with these rules, and at a recent meeting of the Board, a Committee, consisting of five elder members of the Society (Messrs. Kirkwood, Craven, Adams, Greene and Morse) was appointed to arrange the names of the members of the Society in order of seniority. A report from the Committee is expected at this time.

At the Annual Meeting, changes in the By-Laws were proposed, declaring how special committees on engineering subjects shall be appointed, and Annual Conventions managed; that ex-Presidents of the Society shall be Honorary Members; instituting officers' receptions, and permitting an abstract instead of an original paper to be published. These were

duly referred to the Board and its recommendation thereon made to the Society, December 1st. January 5th and February 2d the several amendments were considered; the following were adopted:

Addition to SECTION 1. A Convention of the Society for professional discussion and social intercourse shall be held annually at such place as the Society may determine, and be presided over by a Chairman selected from among Members not officers of the Society. During the Convention, a regular meeting of the Society to be presided over by the officers of the Society, may be held for the transaction of business.

The officers of the Society may give a reception at the Society's rooms, on the evening of the second and fourth Wednesday of each month between October and April, for the purpose of informal professional conversation and social intercourse. Regulations concerning refreshments and the invitation of guests may be made by a committee appointed for the purpose, but shall be without expense to the Society.

Addition to SECTION 16. When however, the Library Committee do not feel authorized to publish a paper, they may provide an abstract thereof, which, when approved by the author, may be published instead of the original paper.

SECTION 31. Special committees to report upon engineering subjects shall be authorized only by a majority of the votes cast by the Society, and in the following manner: Any resolution proposing such a committee shall be referred to the Board of Direction, which shall examine the same and report to the Society a concise statement of the argument for and against the appointment of such committee, which statement shall be printed and issued to this Society with letter ballot; or, if the Board fails to report within one month, the letter ballot shall be issued without comment; or, the Society may vote by ballot at the Annual Meeting, or in the Annual Convention upon such resolution, within one month after it has been submitted to the Board of Direction.

SECTION 32. The President of the Society shall have the general supervision of the business and correspondence of the Society; he shall be an honorary member of all committees, but shall have no vote on such committees.

This section and its substitutes were made a special order of business at the Annual Convention:

Upon application to the Society for professional service, the President and Board of Direction shall in each case take such action as they may deem best. If they appoint members for the service, the President shall make the nominations, subject to revision and addition by the Board.

1*st substitute.* Upon application to the Society for professional service, the President shall in such case recommend members therefor, subject to revision and addition by the Board of Direction;—and

2*d substitute.* Applications to the Society for professional service shall be referred to the President and Board of Direction for suitable action.

After debate, this section and its substitutes were rejected, and the following was adopted:

Resolved, that in the opinion of this Convention, it is inexpedient for the officers of the Society to take action upon applications for members to perform professional service.

At the Annual Meeting, the Past Treasurer, after reading his Report, announced that he would be unable to serve longer in that capacity. The Board would here record its appreciation of the long, self-sacrificing and efficient services rendered this Society from its organization to the present time, by Mr. James O. Morse, as Vice-President, Secretary, Treasurer and Director, for which he is to be held in grateful remembrance and high esteem by the membership now enjoying the fruits of his labors.

The general report of the Treasurer of the Society on the state of its finances for year ending yesterday is herewith presented.

During the year deaths of members have been announced as follows:

William H. Aspinwall, admitted as Fellow, July 9th, 1870, who died January 18th, 1875.

William Y. Arthur, C. E., admitted as Member, January 2d, 1868, and as Fellow, September 20th, 1870, who died February 15th, 1876.

P. Porter Ponier, C. E., admitted as Junior, March 9th, 1875, who died June 11th, 1876.

William Williams, admitted as Fellow, June 20th, 1870, who died September 10th, 1876.

Memoirs of the deceased are in preparation and will be presented in due course.

Respectfully submitted,

G. LEVERICH, Secretary.

REPORTS OF COMMITTEES.

OF THE BOARD OF CENSORS TO AWARD THE NORMAN MEDAL.

ACCEPTED NOVEMBER 1ST, 1876.

The Board of Censors for awarding the Norman Medal respectfully report that a single paper only has been submitted to them.

While this paper is certainly of practical engineering interest and is a clear descriptive account of an important engineering work, it is deficient in some respects as a competitive paper. If the illustrations had been presented as a part of the paper, it would have had greater value. The requirement of the author to have them returned, prevents the Censors from considering them in connection with the text. The Board, therefore, declines to make any award.

Respectfully submitted,

GEORGE S. GREENE,
F. A. P. BARNARD,
J. G. BARNARD,
} Board of Censors.

ON TIME AND PLACE OF THE NINTH ANNUAL CONVENTION.

ACCEPTED NOVEMBER 1ST, 1876.

The Secretary, as Committee on Time and Place of the Ninth Annual Convention, has to report that replies to circulars sent out, have been received from 118 members.

Of these, as to time, 32 name June, 12 May, 8 February, 3 each April and July, 2 March, 1 each January, August and November, and 55 express no choice; and as to place, 19 name New Orleans, 18 New York, 10 Washington, 8 Boston, 5 Chicago, 3 Cleveland, 2 each Ithaca, Rochester and San Francisco, 1 each Baltimore, Cincinnati, Niagara, Providence, St. Louis and Troy, and 43 express no choice.

It will be seen there is not a majority of votes in favor of either time or place named. The Secretary has received communications from Messrs. Corthell, Forshey and Howell,* Members in New Orleans, setting forth the desirability of holding the next Convention of the Society in that city, early next year, and these with this report, are respectfully submitted for such action as may now be deemed best.

Respectfully submitted,

G. LEVERICH, Secretary.

* Page 164.

On Tests of American Iron and Steel.

Accepted November 1st, 1876.

The Committee on Tests of American Iron and Steel begs leave to submit the following report.

During the last session of Congress, through the efforts of your Committee, aided by many members of the Society, resolutions were passed by the leading technological and scientific institutions of our country, strongly urging Congress to appropriate the funds necessary to carry on the work begun by the United States Testing Board.

The "American Institute of Mining Engineers" and the "American Iron and Steel Association," heartily joined our Society in asking Congress to grant the needed appropriation. Many learned societies and prominent manufacturers and workers of iron and steel, joined in the effort that was made to lay the matter before Congress so clearly as to render the claims apparent and so secure the appropriation, as it was thought, without a doubt.

The various resolutions were printed and supplied to members of Congress, together with a memorial prepared by this Committee. The Chairman and Secretary of the committee, also visited Washington repeatedly while Congress was in session, and endeavored to give to members, the necessary explanations and to urge them to favor the appropriation. Many members of our Society wrote to their friends in Congress to the same end. In short, everything was done that seemed necessary to induce Congress to appropriate money to carry on the work of the Board for another year.

An unaccountable delay in the completion of the testing machine contracted for by the Board has prevented such progress in its work as would have enabled its friends to refer Congress to valuable results reached; and this, in connection with the effort at retrenchment in the expenditures of the government made during the last session of Congress, prevented any new appropriation of money for the use of the Board.

The unexpended balance of the former appropriation was however re-appropriated with a provision, that when this is expended, the Board shall be dissolved. Therefore, unless Congress can be induced at its next session to amend its action, the Board is legislated out of existence before its work is more than fairly commenced.

To the members of our Society, it will not seem strange that more has not been done, when they are informed that the testing machine, owing to the novelty of its plan, and the peculiar characteristics of the contractor engaged in building it, is not yet done. It must also be remarked that with the exception of $1 200 per annum paid the Secretary, the civil engineers, members of the Board, receive no compensation, and the army and navy officers are not relieved from their other regular duties, but have to give to this work only such time as they can spare from their ordinary labors.

Under these circumstances, the members of the Board cannot be expected to devote their whole time and attention to the work. And yet, its magnitude and importance are such as to require the constant well directed efforts of the seven members constituting the Board, for several years to come. This assertion needs no argument or explanation when addressed to the members of the American Society of Civil Engineers; for no body or class of men in our country is better fitted than they to appreciate its truth when made without comment.

We should therefore address ourselves to Congress once more and ask the repeal of so much of the Sundry Civil Appropriation Bill passed during the last session as will, if not repealed, dissolve the Board when the present appropriation is expended; and a new appropriation of at least $50 000 should be granted for the work during the next fiscal year.

It is hoped that the efforts of our Society will be redoubled rather than relaxed, in view of the difficulties already encountered in pushing forward an investigation in which we all have so deep an interest.

The new steels are now produced of such uniform strength and toughness as to render their extensive use in this country for bridge building and other constructions at an early day almost certain, if their characteristics can be made generally known; and nothing will sooner disseminate the confidence in their fitness for such purposes, which must precede application to them, than the tests proposed. By the use of these steels for bridges, longer spans will become practicable, and moderate spans can be made lighter and cheaper than they now are, of iron.

The work of the Board, if faithfully performed, will aid us in making this important step in advance. This alone should induce us to increase our efforts to influence our govern-

ment to grant the means necessary to develop a thorough acquaintance with the metals which our people already produces largely. The manufacture of the new steels has become a very important and promising industry in the United States, and their general use in bridge building would produce a sudden and enormous increase in the demand for them.

It has seemed appropriate that the American Society of Civil Engineers should take the lead in this effort to procure knowledge that is so much needed by the civil engineers of our country, so conducive to the success and increase of some of our most fruitful and promising industries, and so essential to the safety and well being of our entire people; and this committee ventures to ask once more the individual aid of every member of the Society, to procure from Congress the support necessary to carry the work on to completion.

Our government may have the proud honor to be the first to procure for its people, a thorough knowledge of the metals manufactured and used by them. The work of obtaining it has been auspiciously begun, and it is so beneficent in its promise, that all parties should vie with each other in procuring this knowledge and spreading it before the public.

WM. SOOY SMITH, Chairman.

OF THE CENTENNIAL COMMISSION OF THE SOCIETY.

PRESENTED NOVEMBER 1ST, 1876.

At the time this Commission was organized, what it would be able to accomplish was very imperfectly known. How far engineers and others would respond to the call for interesting exhibits, and what would be the prospect of raising the required funds for carrying out the objects of the Society, could only be conjectured from our knowledge of the interest in the matter exhibited by the Society generally. Although the Commission was organized at too late a day to do all that might have been accomplished by an earlier effort, the time before the opening of the Exposition was used by the several members of the sub-committees to such advantage, that they succeeded admirably in making a creditable display of American engineering at our rooms in the Main Building.

The question that met the committee in charge of the local arrangements, in Philadelphia, at the outset was, whether we should be able to fill the space allotted to us, which was the south room in the west gallery in the Main Building, 20 by 40 feet in size. We are now not only filling that, but another room of the same size at the other end of the gallery and the whole intermediate space—about five times the original assignment. There are also interesting engineering exhibits in various parts of the buildings which would have been presented under our auspices, had there been beforehand a full understanding of our position, intentions and possibilities. A record of all these has, however, been kept at our rooms by the Resident Secretary, Mr. John Bogart, and engineers visiting our exhibition have had their attention directed to them.

The collection which the Commission has brought together, represents the progress and present condition of engineering in the United States, and is, without doubt, the most complete ever made in this country. The occasion of the Great Exhibition has brought out much that would have otherwise remained unknown, and has induced engineers and others to exert themselves in furnishing all that might be interesting to engineers both of this and foreign countries. In some of the divisions our exhibit is excellent and in general, it is sufficiently comprehensive to give full data to those who have agreed to perpetuate in memoirs, the present state of engineering science as shown by the Great Exhibition.

The Resident Secretary of the Commission at Philadelphia has endeavored to give to foreign engineers, and to all other foreigners visiting our rooms, every professional information which they sought, or which it was considered would be of interest to them. Personal and social attention has also been given, as far as practicable, to those who visited us from abroad. There is no doubt but that both the professional and personal attentions afforded by the arrangements of the Commission have been thoroughly appreciated.

The effort has been made to show to foreigners, what American engineers have accomplished, what they can do, and how largely their practice is scientific and not empirical. In the opinion of the Commission—and in this it is seconded by many who have visited the Exhibition—an increased respect for American engineers, a greater confidence in their abilities, and a deserved admiration for their successful accomplishment of diffi-

cult works, have been firmly established. Hereafter the works and acquirements of American engineers will be better known, and they can successfully compete with those of other nations, anywhere in the world. They will be sure to receive all professional and practical attention and respect. Socially, an American engineer will everywhere receive a hearty welcome.

The permanent benefit to the Society from the results of the Exhibition will be large. Many of the collections both from the United States and various foreign countries, have been or will be presented to the Society, and the memoirs that will be prepared by the members of the Commission and others, will be a valuable addition to our knowledge upon the several branches of engineering of which they treat. They will be without doubt a very valuable and correct record of the history, progress and present condition of engineering in this country. A committee of the Commission is now considering the best means of publishing these memoirs.

The Commission has been somewhat hampered by the lack of funds. The number of articles collected, the space occupied and attention required, have all been so much larger than was anticipated, that the original estimate of funds required was quite moderate.

The sum first estimated by the Commission as required for the purposes of the Exhibition will not be exceeded, and will be a small and reasonable cost for the advantages that have been secured. The whole amount needed has not yet been raised. There is still about $1 000 required to make up the original sum, and this must be had in some way to complete our arrangements and pay our debts.

THEODORE G. ELLIS, Chairman.

OF COMMITTEE ON FINANCE, OF THE CENTENNIAL COMMISSION.

ACCEPTED NOVEMBER 1ST, 1876.

The total amount paid into this fund to date is $4 101. This sum has been subscribed by about 125 persons, of whom about 120 are members of the Society. There are about $100 subscribed but not yet paid in; leaving, according to the last estimate of Mr. John Bogart, Resident Secretary, about $800 yet to be provided for.

Respectfully submitted,

W. MILNOR ROBERTS, Chairman.

ON UNIFORM ACCOUNTS AND RETURNS OF RAILROAD COMPANIES.

ACCEPTED NOVEMBER 1ST, 1876.

The committee appointed to consider the subject of "Railway Accounts and Returns," as presented in the paper read by William P. Shinn, at the Eighth Annual Convention,* respectfully reports as follows:

The Railroad Commissioners of Massachusetts were authorized by the Legislature at its last session to prepare and adopt, a system of accounts and form of returns corresponding therewith, which should be used by all the railroad companies of Massachusetts.

The Committee considered it very important that the system of accounts and form of returns adopted by the Massachusetts Commissioners should be well considered, to the end that such should embody correct principles and furnish such details as are necessary to the formation of correct opinions in regard to the financial condition of the railroad companies, and the economy of their management, as, if their adoption in Massachusetts should prove a success, they are likely to be copied by the commissioners of other States.

The Committee has therefore, by correspondence and an interview with the Chief Accountant of the Massachusetts Commission, sought to secure the adoption of what we regarded as important amendments to the original plan of the Commission, in some which we have been successful, and we hope to succeed with all the more important.

This Committee would therefore recommend the appointment of a Committee of three, on the subject of Railway Accounts and Returns, with authority to correspond or meet with the commissioners on railroads of the several states requiring returns, with a view to securing the adoption, so far as possible, of a uniform system of accounts and returns. *

For the Committee,

WM. P. SHINN, Chairman.

* CXXIV. On Railroad Accounts and Returns: W. P. Shinn; Transactions, Vol. V, page 215.

* William P. Shinn, Octave Chanute and Frederick de Funiak were appointed such Committee.

BOOK NOTES.

REPORTS OF THE VIENNA INTERNATIONAL EXHIBITION.*—By an Act of Congress, approved June 10th, 1872, the President of the United States was authorized to appoint representatives of the United States to attend the proposed exhibition to be held at Vienna in 1873. By joint resolution of February 14th, 1873, the President was authorized to appoint a "Commission of scientific Men," and a "Commission of practical Artisans" to attend the exhibition and to report to him their observations.

The two Commissions were accordingly appointed, and their reports, presented subsequently, have recently been published by the Department of State and presented to Congress. This large mass of material was placed in the hands of Robert H. Thurston (Member of the Scientific Commission, and also of this Society), as editor. The work is issued from the Government press in four large octavo volumes.

In Volume I, the editor prefaces the report with a somewhat full historical account of the origin and progress of industrial exhibitions, from the "fairs" of the middle ages to those of modern times, and to the now well known international exhibitions of which the Centennial Exhibition of Philadelphia is the latest. The editor's account of the inception, organization and administration of the Vienna Exhibition occupies something more than 150 pages, and is very complete, including lists of awards and of the International Jury, and an account of the methods of jury work.

Copious extracts from British reports and translations from the French, German, Austrian and other reports on exhibits from the United States follow, regarding which the editor remarks in his preface: "It has been thought advisable to supplement the reports of official representatives of the United States by abstracts of the official reports of other nations where the latter have been found to contain criticisms of the exhibits of the United States section. Such criticisms made, as they are, by the ablest men of Europe, are extremely valuable as indicating not only the judgment of acknowledged experts in their several branches, but as exhibiting the real standing of our manufacturers and producers with the people of Europe, and as enabling our countrymen to see themselves as others see them."

The editor further remarks, in a preface to these foreign reports: "It is a subject of congratulation and will be a source of real pleasure to every citizen of the United States that these criticisms are so generally favorable. They are even, in fact, more favorable than they at first glance, might appear. In reading them, it is to be remembered that the foreign writer—born and bred in distant countries, under influences with which the citizen of the United States is unfamiliar, and from which he is fortunately free, accustomed to habits of thought, and familiar with methods, which are equally strange to those whose work he criticises, viewing the subject of his criticism from an entirely different stand-point, and through a medium of very different hue—must necessarily be placed at some disadvantage. He cannot be expected to see the real value of American productions, taken apart from the peculiar circumstances which have brought them into existence. The real bearing of the distinctions arising between the older nations of the Eastern Continent which are slowly progressive, stationary, or even retrograde in their changes, in which conservatism and tradition have almost absolute sway, in which ambition is stifled, before the citizen reaches the age of manhood, by the evident, almost absolute impossibility of advancement, except as the death of those already occupying place, opens new opportunities at home, and migration to another land is the only alternative, with a life of laborious poverty and obscurity, where every effort at progress is difficult; and the young nation which is barely a century old, and in which ambition, energy and character have open field and a full reward, is not, and cannot be, appreciated by those who have seen and felt only one of these two opposite sets of conditions. Still less is it possible, for the man who has been subjected to the one, to criticise the methods and the work of the man who has labored under the other, until he has seen, felt and intelligently studied the circumstances controlling the latter."

* Reports of the Commissioners of the United States to the International Exhibition held at Vienna, 1873.—Published by the Secretary of State, by authority of Congress. Edited by Robert H. Thurston. A. M., C. E., Prof. of Mechanical Engineering at the Stevens Institute of Technology, and Member of the Scientific Commission of the United States. 4 vols. Washington, 8vo, illus., pp. 3500. 1876.

The foreign reports occupy over 250 pages and as well as the introduction, are thoroughly indexed. They are principally devoted to subjects interesting to the engineer. The remaining portion of the first volume is occupied by the reports of H. Garretson, Chief Executive Commissioner; J. A. Warder, of Ohio, on Forestry, and J. R. Dodge, of the Bureau of Agriculture, on Sheep and Wool. The former contains an extended and very complete account of the forests and forest products of Europe, of forest management and of the European schools of forestry. A large amount of valuable statistics and of information relating to the cultivation and use of timber is here given, as collected by the writer of the report from publications and by observation. References are given in all cases. The report of Mr. Dodge is a somewhat extended treatise on sheep-husbandry and wool-growing, and is well illustrated.

Volume II contains the reports on science and on education.

Prof. Horsford presents a complete treatise on the art of milling and of bread-making, as practised in Austria, Hungary and on the manufacture of the celebrated Vienna bread, giving analysis of flour and of the several varieties of wheat from which it is made. This is probably the only scientific treatise on the baker's art ever printed. Prof. Collier's report on Commercial Fertilizers is systematic and very exhaustive.

Prof. Gibb's report on Physical Apparatus is likely to prove useful to all who use scientific apparatus, containing, as it does, the prices and specifications of the best European makers. Reports on Instruments of Precision, by C. F. Carpenter and R. D. Cutts, will interest engineers, as they contain descriptions of foreign made engineers' instruments. R. B. Lines and David Brooks report on Telegraphs, the former also devoting considerable space to telegraph-administration and statistics, as well as to apparatus, and the latter describing methods of line construction and management.

Edward Sequin, Sen., of New York, reports on the subject of primary education, and taking as his standpoint that of the physiologist, treats at great length and with entire originality, the bearing of known physiological facts upon the training and instruction of children and of the deaf and mute. A very important class of facts are here for the first time presented and in a thoroughly well considered and attractive form. This volume also contains reports on printing and governmental publication, by G. W. Silcox and A. H. Brown.

Volume III is devoted to Engineering. The report of Prof. Thurston is a large work of nearly 500 pages, illustrated by about 225 engravings, of machinery, views of the machinery exhibit and of European manufacturing places, and embodies a cyclopedic review of the group (XIII. Machinery) to which the author was assigned as a member of the International Jury. The introduction describes the exhibit as a whole, the methods of jury-work, and states the results of the exhibition as affecting exhibitors from the United States. British manufacturers are considered to excel, as a rule, in the solidity and strength of their products; American makers to have been far in advance in the ingenuity displayed in their designs and in all varieties of so-called "labor-saving" and special machines and continental European builders to exhibit great intelligence in copying British and American designs, but not to have given evidence of inventive talent or skill in original design.

The work is divided into two parts. Part I is devoted to machinery exhibited at Vienna, and Part II, to an account of European manufacturing districts and to statistics of production as found by the writer of the report, during a tour made, after leaving Vienna. In Part I, chapters are devoted, to stationary, marine, locomotive, traction and portable engines, to steam boilers, air and gas engines, hydraulic motors, pumps and machine-tools, to textile and miscellaneous machinery and to a general review of the whole field. Historical sketches usually precede the description of exhibits in each class and frequently, short statements of the principles of construction and of conditions of efficiency and economy accompanying these sketches.

The progress of modern improvement in the steam-engine is traced, and the circumstances which led to the introduction of the "detachable valve-gear" and of compound engines are stated, and a concise statement of the conditions of efficiency is given. Illustrated descriptions of the most remarkable American and European engines follow. A similar treatment of marine steam-engines includes a reference to the peculiarities of surface-condensation, and data relating to performance of the several classes of engines, and an analytical consideration of the loss of power in paddle-wheel propulsion. The chapter on locomotion contains a complete

discussion of the Guinotte valve-motion, of the relative value of steel and iron in construction and of methods of work. A chapter is devoted to a history of steam-traction on the common road, to accounts of experiments on traction force and economy of road-locomotives, including the trial of road-steamers by the author at South Orange, N. J. The forms, proportions and performance on trial of the various forms of steam-boiler, and a description of their appurtenances, and a statement of the principles governing their design and construction occupies a chapter, and includes the theory of the Giffard injector. The chapter on air and gas engines contains data relating to their economical performance, their theory, and a comparison with steam-engines. The trials recorded were made by Tresca, in France, and by Thurston, in the United States.

The water-wheel and pumps exhibited, are described, their theoretical value noted and a comparison made between steam and water-power. In building turbine wheels, as in constructing expansion steam-engines, manufacturers in the United States are considered to equal and even to excel, foreign makers. Nearly 100 pages are devoted to metal and wood working machinery, of which many illustrations are given. Both the author and the foreign authorities quoted, concede superiority in labor-saving and special machinery to American makers, whose ingenuity is unapproached by European designers. British builders are considered to excel in solidity of work.

In the chapter on miscellaneous exhibits, a full description of the methods of making compressed steel by the Whitworth process, and bronze by the process of S. B. Dean, and Gen. Uchatius, appears.

Part II gives a large collection of statistics of European manufactures, description of manufacturing establishments, and an account of the iron making countries. Among the most important sections are those devoted to the Cumberland and the Cleveland iron-making districts, iron-ship building, the British naval establishment and policy, and new methods of work observed in Great Britain.

The full page illustrations include a number of remarkable photo-lithographs, showing the interior of machinery-hall and the machinery, exhibited in wonderful detail. A complete index occupies the last 15 pages.

The report on sewing machines, by Mr. Fairfield, gives illustrated descriptions of the exhibits in that class, and an account of the method of manufacture which has become standard in the United States.

The report of Prof. Watson on Civil Engineering is comparatively short, but contains much valuable information. It gives an account of the Boulle Viaduct, with plans, specifications and estimates, and statements of weight and cost. An iron viaduct over the Isse is described similarly. Nearly 20 pages are given to an account of the river improvements in France, the barrages adopted, Girard's sluice, and the overfall at Brulée Island, the lock and barrage at Port à l'Anglaise, and the feeding of the canal between the Aisne and the Marne, including the pumping establishment at Condé. The account of the Aubois Canal lock, and the description of an apparatus used to measure directly the strains in girders, are valuable to the engineer. The appendix contains a minute description of the national school of roads and bridges at Paris. All of these subjects were especially noted by the jury, and received awards. The engravings are numerous and include many large folding sheets of drawings.

The report of Mr. Davis on Hydraulic Engineering is short. It includes an account of the Danube regulation, the water supply of Vienna, and some notices of French and Italian work.

The several reports on Architecture in Volume IV, describe with drawings and some fine engravings, the buildings of the Exhibition and of Vienna, methods and materials of construction, and the wood and stone working observed at Vienna. Prof. Blake's Report on Iron and Steel is a very full account of those industries in Europe, and contains valuable descriptions of the Haswell process of "hydraulic forging," the Seller's puddling machine, and a very complete account of Swedish iron ores and methods of iron-making. Mr. Painter's report treats similarly the metallurgy of the other metals, as observed in Europe, particularly of lead, copper and silver. Both of these reports are largely statistical and are likely to prove exceedingly valuable.

The General Index to the four volumes of reports has been made by the editor exceptionally full, and occupies over 80 pages. It is an index of volumes, pages and articles, and nearly every paragraph in the whole collection is noted. Probably no more complete system of indexing was ever adopted in any work of this character. The tables of contents, general and special, are equally complete. In this respect and in fullness of

illustration, no work could well be more complete, and in these volumes, the two Commissions to Vienna have given an immense mass of information.

ANALYTICAL MECHANICS*:—This work purports to treat of the elements of analytical mechanics. The author uses any branch of mathematics, including the calculus, which will serve his purpose. The subject is presented by topics, a form of treatment which is desirable for the class-room. The principles are illustrated by numerous practical examples, many of which appear to be original.

The work is not as abstruse as some which have been written upon this subject, and yet we apprehend that it is sufficiently so, for the majority of students who will study it. As the author expressly states, it is intended to lay the foundation for the study of *analytical* mechanics, and not for an advanced work upon the subject. If we compare its grade with two other works which are considerably used in this country, we would say that it is intermediate between Smith's and Bartlett's Mechanics, although we find in this work nearly all the principles pertaining to solids which are given by Bartlett.

The author sets out with a few elementary principles, and early in the work establishes the fundamental equations of the motions of a particle acted upon by a single force. The student is thus early brought to the consideration of forces in an abstract form and to their effect upon bodies free to move.

The work is not divided into the grand subjects of Statics and Dynamics. Some of the principles of Dynamics are presented in the first chapter, then follow several chapters on Statics, after which Dynamics are resumed and continued to the end of the book. Statics are considered as a limiting case of Dynamics, in which the motion is zero.

The clear and positive statements of the author upon the subjects of Inertia, Work, Momentum, Impulsive Force, and Moments of Inertia will be refreshing to the reader. The language is well calculated to remove all doubts or ambiguity in regard to the real meaning of these terms.

The general arrangement of the work is on the progressive plan; that is, it begins with the more elementary parts of the subject and goes deeper and deeper into it to the end; the last chapter containing the most general equations of the motion of a solid, and several applications of them.

* The Elements of Analytical Mechanics. By DeVolson Wood. A. M., C. E., Prof. of Mathematics and Mechanics in the Stevens Institute of Technology. New York. 8vo, illus. John Wiley & Sons.

NOTES AND MEMORANDA.

SELECTIONS FROM CORRESPONDENCE.

DAMS FOR RESERVOIRS.*—Specifications for repairing the break in the dam of the storing reservoir for the Worcester Water Works, on Lynde brook, in the town of Leicester. Wm. J. McAlpine.

General description.—The former dam was made of 50 feet width on top, and slopes on each side of two horizontal to one vertical, and 40 feet above the base. It was arranged that it could be hereafter built to a level, 5 feet higher, which would have reduced the top width to 30 feet. Although the dam now remaining is of unnecessary width on the top, yet for appearance' sake the same outlines will be maintained in the new work of repairs.

The space opened by the breach will be filled with an earthen embankment, in the middle of which will be a puddle wall, and transversely through the bank will be placed three lines of cast iron pipes resting upon and enveloped in a wall of rubble masonry, and connected with three cut-off walls of masonry. At the upper end of the pipes, near the foot of the upper slope, will be erected a regulating gate house, and near the foot of the lower slope, a gate well, both of rubble masonry. The upper face of the new embankment will be protected by a slope wall pavement, of the same character as that now upon the face of the old dam. The present waste way will be maintained as heretofore, except that the provision for the insertion of flash boards will be removed. The new gate house will be arranged to act also as an additional waste way, discharging at the same level as the present weir.

The important features in the restoration of the dam consist:

* In consequence of one half page having been omitted from this article, when previously published, (page 98), it is reproduced in correct form.

First.—Of the removal of the whole of the bottom part of the former "spiling walls."

Second.—Of cutting off, 6 feet in length of the original supply and waste pipes, directly under the new puddle wall.

Third.—The founding of the bottom of the new puddle wall into the water-tight original soil by toothing, as shown on the plans, and by jutting vertically and horizontally into the steps with the same toothing. Where the former banks are found to be of good material and to have been carried down into water-tight natural soil, and when such banks have not been disturbed by cracks and slides, they are to be considered as equal to the natural banks, and the puddle wall is to be founded, toothed and stepped into them, as before mentioned, for the water-tight natural earth.

Fourth.—The new embankment above the centre line of the dam will be founded by stepping into, toothing and jutting, as described for the puddle wall, but to a less extent; that is, the jutting may be made at intervals of 10 feet (transversly to the line of the embankment), and from 2 to 4 feet deep back into the present banks.

Wherever the natural or former built banks have been disturbed by cracks and slides, the earth must be removed beyond them and the vertical and horizontal juttings made into the firm earth, as before mentioned. An essential feature in connecting the new puddle and embankment with natural and artificial banks, is to break up all of the continuous vertical and horizontal lines, and to intermix and incorporate the new with the existing material on the bottom and sides of the breach.

The lower half of the embankment will be made by removing the disturbed portions of the existing banks and by breaking up the continuous lines of union and by incorporating the new with the existing material, but none of these are to be done to the same extent as required in the upper half of the embankment.

Fifth.—The pipes must be laid in a straight line vertically and horizontally, and must be supported by a continuous wall of rubble cement masonry resting on the solid water-tight earth extending from the gate house to the gate well. To prevent the water from the reservoir following the pipes and wall, the latter must be extended to completely envelop the former in masonry, and three transverse cut-off walls must be built into the supporting wall, and extended 2 feet deeper and higher and 3 to 6 feet wider, than the supporting wall.

All of these walls must be bedded into trenches sunk 1 or 2 feet into solid water-tight soil, the earth broken up and the base of the wall made of stone of irregular and rough surfaces on the bottom. All of the faces, ends and top are to be of similar and very rough surfaced stone, wherever they are to come in contact with the earth.

Sixth.—The earth which formed the previous dam appears to be throughout of an excellent water-tight quality. The material for the puddle may be taken from the best selected earth, freed of stone and mixed with one-fourth part of fine gravel free from fine sand. The upper half of the new embankment may be taken from the same good water-tight material, free from all vegetable matter and from large stones and rocks. The lower half may be made of good fair material, free from vegetable matter, and the lower slope, for 10 feet horizontal width, may be made of stone, rocks and other refuse materials from the earth used in the upper part of the dam (except roots and woody matter), care being taken to place the other vegetable matter (muck, soil, etc.,) entirely on the outer slope.

The supporting walls for the pipes may be of any sound quality of stone, without regard to size or regularity for those in contact with the earth, but those directly under the pipes should be larger and of more regular beds and build and laid compactly in hydraulic cement mortar.

The stone for the gate house and the gate well should be of sound, durable, well shaped and large sized stone, such as will make good rubble masonry, and give a good, fair, regular face on the outside and inside of the gate house and well. The whole to be well bonded and laid up compactly in mortar of hydraulic cement. The waste or overflow at the level of top water in the reservoir, may be made of the cut stone blocks from the old gate house, and any surplus of such cut stone may be laid for the quoins of the upper portion of the well. The foundation of the gate house should be made of sound, durable timber and plank, placed at such depth as to be always wet.

Seventh.—The selection of the material should commence at the borrow pit, by using the best of the material, breaking up the lumps and throwing aside all stones of more than 2 inches in diameter. When the earth is deposited along side of the puddle wall, the same selections and breaking up is to be continued, and again when it is strewn.

The puddle wall should be made as follows: The selected materials deposited (the clay soil on one side and the fine gravel on the

other side) along the wall should be distributed by strewing thin layers with the shovel, giving the proper proportion of each by having three men strew the clay and one the gravel, and a fifth man sprinkling with water, (being careful to avoid any excess of water), until a depth of 6 inches is obtained.

When the puddle stuff has been thus prepared and tempered with water, it is to be cut and cross-cut with spades, in cuts not exceeding one inch in width, taking care that the spades are forced down into the lower course of puddle to thoroughly incorporate the whole mass.

In rainy weather, or when too much water has been used, so as to make the puddle quake like jelly, it must be allowed to remain undisturbed until the excess of water is carried off by absorption and evaporation. Whenever a course of the puddle is finished, and before it can sun-crack, a fresh layer of puddle material must be put on, and whenever the puddle has stood so long as to have lost its moisture, it must be wet and re-cut before an upper course is laid on. Carts must not be allowed to pass over the puddle except where planks are laid down.

The puddle wall must be commenced in the lowest place and be carried up in level courses, but the adjacent embankment must always be built up at least 6 inches higher than the puddle wall.

If necessary, (to be avoided if possible) to carry up the puddle higher in one place than in another, it must be done by racking back in steps of not more than 6 inches depth nor less than 2 feet tread (1 to 4).

Eighth.—The upper half of the embankment (made of the selected materials before mentioned) must be built up in level courses of not exceeding 4 inches thickness, spread evenly by strewing with the shovel and moistening to a proper consistency. The lumps must be broken up fine at the borrow pit, at the dump and when strewn, and a careful selection of the material must be made at each place. The embankment must be commenced at the lowest place, and always be maintained nearly level in both directions, and, if necessary to be built up higher in one place than another, it must be racked back in steps equal to 1 in 4.

The under part of the embankment for 10 to 15 feet high may be made with wheelbarrows; but whether made with carts or barrows, each layer must be thoroughly rolled with heavy, grooved rollers before the succeeding one is put on. That portion of the embankment immediately adjoining the puddle wall should be made almost as compact as the puddle wall, and at 10 or 15 feet distant it should taper off in compactness to that of the remainder of the embankment. The lower half of the embankment will be made with the best materials and care, adjacent to the puddle wall, and less care toward the lower slope. The pavement wall on the upper slope has been previously described. It may be laid directly upon the earthen embankment.

Ninth.—The gate house shall be made 8 by 6 on the inside, with walls 4 feet thick at the bottom, and 2½ feet at the level of top water in the reservoir, and above this there will be arranged a foundation to the house by four brick arches, through which water will flow and wash into the well. The upper house may be of wood or brick, and having access by a small wooden bridge, to the top of the embankment. The foundation of the gate house will be 18 by 16 feet, of pine timbers about 8 by 12 inches covering half the area, and covered with 2-inch pine plank. The outside wall will be provided with three small waste holes of one foot square, closed with a 3 inch plank placed on the foundations. The inlet gates will be of cast iron, 2 by 3 feet, sliding vertically on cast iron frames, three of which will be placed on the upper face of the gate house wall, and protected by a timber and plank frame with wooden screens. In the middle of the inside chamber, a strong frame of wood and plank will be placed and let into the side walls and made water-tight. In this frame will be inserted three cast iron gates of the same size, and provided with iron frames the same as those in the front wall. There will also be a frame with a fine wire cloth screen placed above the gate frame.

The face of the wall through which the iron pipes pass into the gate house will be made smooth, so as to allow a wooden gate to be put down in the water and close up each pipe. These three pipes will be separated in the gate house, by two vertical wooden partitions. The third or waste pipe will be arranged by means of a floor above, to discharge the waste water only, into the partition attached to the waste pipe. All of the gates will be provided with the proper apparatus to raise them and to discharge the supply water into each, or to shut it off from each. The lower gate well will be 8 by 6 feet and 8 feet deep, covered with trap doors. Each of the pipes will have a stop gate, and the waste gate, a curved iron pipe to the discharge culvert. The pipes will be of cast iron of 2 feet interior diameter, and 1¼ inches thickness of metal, connected by leaded joints. Where the pipes pass through the cut-off wall and at the gate house,

there will be placed, an exterior flange of 42 inches exterior diameter, which is to be leaded to the exterior of the pipe.

THE NINTH ANNUAL CONVENTION.—At the Twenty-Fourth Annual Meeting, the following, received by the Secretary, referring to time and place of the next Convention of the Society, were read.

FROM CAPT. CHARLES W. HOWELL, October 24th.—In naming time and place for next Annual Convention of the Society, there are reasons for preference, which I beg leave to submit through you to the members attending the Annual Meeting, in more detail than the space on blank sent me, permits.

About the middle of April, the weather at New Orleans is usually very pleasant, and the city offers many attractions to visitors from the north. The works of river and harbor improvement in the vicinity of the city are among the most interesting in the country. The Mississippi Delta is, in many respects, the Holland of America. The engineering problems it presents, are now looming up and in the early future will claim general attention. Personal inspection will aid members of the Society in appreciating, on taking part in future discussion of plans for obtaining a permanent and adequate navigable channel between the Mississippi and the sea. It will aid in discussion of the problem of land reclamation or protection by levees, &c.

The protection of the cities of New Orleans and Galveston from storm tides, and the drainage and water supply of these cities, will furnish interesting subjects for investigation.

There are to be seen about New Orleans some interesting examples of the founding of heavy structures on a compressible soil. The compressing of cotton, the manufacture of ice and of sugar, can perhaps be witnessed here in as great perfection as elsewhere. In Atchafalaya Bay and in Galveston Bay we have examples of artificial channels, similar to that leading into Baltimore Harbor. The subaqueous gabionades for improvement of the entrance to Galveston harbor, are worthy of inspection.

There are several Members of the Society here, among whom I mention Mr. James B. Eads, Mr. George W. R. Bayley, Mr. Elmir L. Corthell, Prof. Charles G. Forshey, and myself, who, acting as a local committee, I think can secure the following :—Excursion fares over the railroads entering New Orleans ; good quarters and reduced rates at hotels, &c. ; excursions about New Orleans, to the Passes of the Mississippi and to Galveston, at but little or no expense to members, and the most hospitable reception by the people of New Orleans and Galveston generally.

April is about the middle of our busy season here. Our works can be seen to the best advantage then, while at the same time we would not be able to attend the Convention elsewhere. Perhaps then, works in the north will generally be in condition to allow engineers in charge, absence for a few days.

Distribution of members considered, it must be admitted that New Orleans is not nearly a central point, but it is hoped, in view of what can be presented here, that this will not have great influence against choice of this city for meeting of the Convention.

FROM PROF. CHARLES G. FORSHEY, October 25th. * * It is our conclusion to urge the Society to accept our invitation and make New Orleans the place of the next Convention, and to appoint for the time any date from April 1st to 15th, next.

It happens that the great works of the improvement of the navigation of the great river of the continent, both by an experiment to jettee its mouth and to deepen the mouth by powerful dredges, are in progress ; and still the question is agitated as the method by canal from the river into the sea.

The improvement of the harbor of Galveston, too, is being attempted by a method nearly new, and the work by that time will be sufficiently advanced to be very interesting to the profession. The season of the year will afford those who have not seen the Mississippi river in its flood, an opportunity of witnessing that sight.

It will be the most delightful season to visit us, and at the same time, at a season you can perhaps, be spared from the north.

One thing we can promise the association, and that is, a most hospitable welcome to our city and reasonable charges from our hotels and places of amusement.

All things taken into consideration, we believe that New Orleans is the place for the next meeting. Please convey to the Society this, our hearty invitation.

FROM MR. ELMIR L. CORTHELL, October 26th. —I have requested for the Society—should the Annual Convention be held in New Orleans—the use of steamboats and steam yacht belonging to Capt. James B. Eads, and of the U.S. Revenue Cutter, for excursions to the jetties; also I have applied for the Chamber of Commerce, as a place of meeting.

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

Under this head will be announced new books on these and kindred subjects, which may be professionally useful to members of the Society.

Acoustics, Light and Heat. W. S. Davis and W. Lees. (Advanced Science Series.) London. *Collins.* (Announcement.)

Aerial Navigation. C. B. Mansfield; with Preface by J. M. Ludlow. London. *Macmillan.* (*New York.* Announcement).

Anthracen; its Constitution, Properties, Manufacture and Derivatives, including artificial Alizarin, Anthrapurpurin, &c., with their Applications in Dyeing and Printing. G. Auerbach. Trans. and ed., from the rev. Manuscript of the Author, by William Crookes. London. *Longmans.* (Announcement.)

Antiquities, Observations on popular ——, chiefly Illustrating the Origin of our vulgar Customs, Ceremonies and Superstitions. John Brand and Henry Ellis. New and rev. ed. London. 8vo, illus. *Chatto & Windus.* 7s. 6d.

Aqueducts of Rome, traced from their Sources to their Mouths. John H. Parker. London. illus. *Parker & Co.* (Announcement.)

Archæology of Rome. John H. Parker. 8 volumes, illus., each complete in itself. Part 7: The Flavian Amphitheatre, commonly called the Colosseum. London. 8vo, illus. *Parker & Co.* 10s. 6d.

Architectural History of the University and Colleges of Cambridge. Prof. Willis. Ed. by John Willis Clark. Cambridge. *University Press.* (Announcement.)

Architecture, Dictionary of Terms used in ——, Building, Fine Arts, &c. John Weale. Ed. with numerous Additions, by Robert Hunt. (Weale's Series.) 5th ed., rev. and cor. London. 12mo. *Crosbey & Lockwood.* 5s.

——— Notes on Irish ——. Earl of Dunraven. Ed. by M. Stokes. Vol. II. London, 4to, illus. *Bell & Sons.* (Announcement.)

——— Studies in mercantile ——. W. S. Ogden. London, folio, illus. *Batsford.* 30s.

Armed Strength of the German Empire. Part I. Organization and Administration; with Map. Compiled in the intelligence Branch of the Quarter-Master-General's Department, Horse Guards. F. C. H. Clarke. (British Government Publication.) London. 8vo. 8s. 6d.

——— ——— of the Netherlands; with Map. F. C. H. Clarke. (British Government Publication.) London. 8vo. 4s.

Assaying and Assay Schemes. Notes on—. Pierre de P. Ricketts. New York. 8vo. *Van Nostrand.* $2.50.

Art, a Plea for —— in the House, with special Reference to the Economy of collecting Works of Art, and the Importance of Taste in Education and Morals. W. J. Loftie, London, illus. *Macmillan. New York.* (Announcement.)

——— Examples of modern British ——. London, 4to, illus. *Bickers.* (Announcement.)

——— in Ornament and Dress. Trans. from French of Charles Blanc. London, illus. *Chapman & Hall.* (Announcement.)

Artillery, Elements of Field ——, designed for the Use of Infantry and Cavalry Officers. Henry Knollys. London. *Blackwoods.* (Announcement.)

——— Exercises. Revision of Part II, Section I. (Parliamentary.) London, 8vo. 6d.

——— Hand-book for the 9-inch Rifled Muzzle-loading Gun of 12 Tons. Do. for the 10-inch Rifled Muzzle-loading Gun of 18 Tons. (Parliamentary.) London. 8vo., each 6d.

Astronomy, the Modern Genesis: being an Inquiry into the Credibility of the nebular Theory of the Origin of planetary Bodies, the Structure of the solar System, and of general cosmical History. W. B. Slaughter. New York. 16mo.

———, without Mathematics. 6th ed., rev. for the Results of the Transit of Venus. Edmund Beckett. London. 8vo. *Ch. Knowl. So.* 8vo. 4s.

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Water Analysis: a practical Treatise on the Examination of potable Water. J. A. Wanklyn and E. T. Chapman. 4th ed. Re-written by J. Alfred Wanklyn. London, 8vo. *Trubner.* 5s.

——— Resources: a Treatise on Water and Springs. Written by Bernard Palissy in 1557. Trans. by E. E. Willett. 8vo, Brighton. *Smith.* 1s.

——— Supply, Notes on ——— ———. L. L. Macasey. London. *Spons (New York).* (Announcement.)

Weights and Measures (simplified), on a natural System applicable to most civilized Nations. Lewis D'A. Jackson. London, 8vo. *Spons (New York).* $1.

World of Switzerland, primæval—. Prof. Heer. Ed, by James Heywood. 3 vols. London, 8vo. *Longmans.* 28s.

Zoology, a 14 Weeks' Course in ———. J. Dorman Steele. New York, 12mo, illus. *Barnes.* $1.50.

———. United States Geographical Surveys West of the 100th Meridian. George M. Wheeler, Lieut. of Engineers, in Charge. Vol. V. Zoology. Washington, 4to, illus. *Gov't. Printing Office.*

ADDITIONS TO

LIBRARY AND MUSEUM.

NOTE.—"Copies for distribution" named in this list, will in order of receipt, be sent to members who apply—until the supply is exhausted.

DONATIONS ARE ACKNOWLEDGED AS FOLLOWS:

From American Iron and Steel Association, Philadelphia, Pa.:

Facts and Arguments in Support of the Policy of Protection to Home Industry. Philadelphia.

From Board of Railroad Commissioners of State of Massachusetts, Boston:

General Instructions in regard to the Keeping of Railroad Accounts.

Report of Railroad Companies to the Board of Railroad Commissions. (6 copies of each.)

From E. Chatelier, Paris, France:

Counter Pressure Steam as a Brake in Locomotive Engines. C. W. Siemans. Birmingham.

Railway Economy. Use of Counter Pressure Steam in the Locomotive Engine as a Brake. L. D. B. Gordon. Edinburgh, 1869.

From J. James R. Croes, New York:

Centennial Commission of the American Society of Civil Engineers, Sub-Committee on Water Works. Catalogue of Exhibits. (A copy for each member.)

From F. de Funiak, Louisville, Ky.:

Annual Report of the Louisville & Nashville R. R. Co., 1874-5. Louisville.

Headings and Forms of Account, Louisville & Nashville and Great Southern R'y.

From R. H. Duell, Commissioner of Patents, Washington:

Rules of Practice in the United States Patent Office. November, 1875. Washington.

From Albert Fink, Louisville, Ky.:

Investigation into Cost of Passenger Traffic on American Railroads, with special Reference to Cost of Mail Service and its Compensation. Albert Fink. Louisville, 1876.

From Charles E. Fowler, New Haven, Conn.:

City Year Book of City of New Haven, for 1875-6. New Haven.

From Estevan A. Fuertes, Ithaca, N. Y.:

Cornell University Register and Catalogue, 1875-6. (Copies for distribution.)

From John W. Hill, Hamilton, Ohio:

Report of Board of Commissioners. Sixth Annual Industrial Exhibition at Cincinnati. 1875.

From Gen. A. A. Humphreys, Chief of Engineers, Washington:

Report of Inspection of Improvement of South Pass of Mississippi River.

Report of Inspection of Improvement of South Pass of Mississippi River. Maj. C. B. Comstock. June 9th, 1876. (Copies for distribution.)

From Institution of Civil Engineers, London:

Excerpts from Minutes of Proceedings. Session 1875-6. Part IV, as follows:

Abstracts of Papers in foreign Transactions and Periodicals.

Evaporative Performance of Steam Boilers. D. Kinnear Clarke.

Permanent Way of Railways. R. Price Williams, with Abstract of Discussion.

Railway Rolling Stock. Brown & Williams.

Resistance of Boiler Flues to Collapse. W. C. Unwin.

Slate Quarrying in the Festiniog District, North Wales. Langley & Bellamy.

List of Members of the Institution. October 2d, 1876.

Private Press. Session, 1875-6. Nos. 1-20. Abstracts of Minutes of Meetings, and of Papers read.

From the Institution of Engineers and Shipbuilders in Scotland, Glasgow:

Transactions of the Institution. Vol. XIX. 1875-6. Glasgow.

From Rear-Adm'l Thornton A. Jenkins, Washington:

Catalogue of Exhibits of U. S. Navy Department, in U. S. Government Building, Philadelphia.

From T. Guilford Smith, Buffalo, N.Y.:

Proposals, Specifications, &c., for rolled Iron Beams, and rivetted Plate and Box Girders for the New York State Capitol, Albany; with Plans.

From George M. Wheeler, Lieut. of Engineers, U. S. A.:

United States Geographical Surveys, West of the 100th Meridian. Lieut. George M. Wheeler, Corps of Engineers U. S. A., in Charge. Vol. V. Zoology. Washington. 1875.

From Miscellaneous Sources:

Annulate Joints for connecting Iron Bars in Bridges and Roofs. Boston.

Lawrence Water Works. First Report of the Board of Experts on the Test trial of the Pumping Engines. New York. 1876.

Newspaper Advertising. G. W. Rowell & Co. 106th ed. New York, 1876.

Proceedings of convention of Car Accountants, representing Railways in United States and Canada, held at Cleveland, O., October 17th-18th, 1876. Cleveland.

Register of Commissioned, warrant and volunteer Officers of the Navy of the United States, including officers of the Marine Corps and others. January, 1876. Washington.

ANNOUNCEMENTS.

MEETINGS OF THE SOCIETY for the first quarter of the present Society year, will be held as follows:—*regular* meetings, when ballots for members will be canvassed and other business done, December 6th, and January 3d; and *stated* meetings, for consideration of professional topics, November 15th, December 20th, and January 17th, at 8 o'clock P.M.

MEETINGS OF THE BOARD OF DIRECTION for the same term will be held for the transaction of regular business, December 6th and January 3d, at 3 o'clock, P. M.

PAPERS HAVE BEEN RECEIVED for presentation to the Society since the last announcement, as follows:—

Notes on the Masonry of the East River Bridge. Francis Collingwood. November 1st, 1876.

On the Rate of Set and Decrease of Resistance of Metals subject to Distortion. Robert H. Thurston. November 3, 1876.

CATALOGUE OF WATER WORKS EXHIBITS, INTERNATIONAL EXHIBITION. By the courtesy of J. James R. Croes, Chairman of Sub-Committee, Centennial Commission of the Society, a Catalogue of these Exhibits, displayed in West Gallery, Main Exposition Building, has recently been sent to each member of the Society.

INSTITUTION OF CIVIL ENGINEERS, LONDON.—Referring to "List of Members" of the Institution, issued October 2d, 1876, the following are noted, as being also members of this Society:

Clarke, Thomas Curtis, [M]. Philadelphia, Pa.
Craven, Alfred Wingate, [M]. New York.
Eads, James Buchanan, [M]. St. Louis, Mo.
Evans, Walton White, [M]. New York.
Fleming, Sandford, [M]. Ottawa, Can.
Fox, Charles Douglas, [M]. London.
Hambleton, Francis H., [A]. Baltimore, Md.
Hjortzberg, Maximilian, [M]. Chicago, Ill.
Keefer, Samuel, [M]. Brockville, Can.
Kennedy, John, [M] Montreal, Can.
Krupp, Alfred, [A]. Essen, Prussia.
McAlpine, William Jarvis, [M]. Babylon, N.Y.
Sandberg, Christer Peter, [A]. London.
Wilson, Joseph M., [M]. Philadelphia, Pa.

As Appendix to this number of the Journal, is issued herewith:—

Discussions on Technical Education, at the Washington meeting of the American Institute of Mining Engineers, February 22d and 23d, 1876, and at a Joint Meeting of the American Society of Civil Engineers and the American Institute of Mining Engineers, at Philadelphia, June 19th and 20th, 1876.

LIST OF MEMBERS.

ADDITIONS.

		Date of Election.
NEWTON, WILLIAM H.	Civil Eng., 80 La Salle street, Chicago, Ill.	June 7, 1876.
NICHOLS, OTHNIEL F.	Civil Eng., 81 Carlton av., Brooklyn, N. Y.	" " "
PETTIT, ROBERT E.	As't Eng., P. R.R., Harrisburg, Pa.	Nov. 1, "
STEVENS, HORACE E. [J.]	U. S. As't Civil Eng., St. Paul, Minn.	" " "
WARFIELD, ALBERT G., Jr.	Engineer Dep't S. P. R. R., San Francisco, Cal.	Oct. 4, "

CHANGES AND CORRECTIONS.

BAXTER, GEORGE S. ..... 244 E. 13th st., New York.
BEEBOUT, EDWARD N. ..... Canton, O.
BILLIN, CHARLES E. ..... Ass't Geological Survey of Pennsylvania, 1008 Clinton st., Philadelphia, Pa.
CARTWRIGHT HENRY ..... Mech. Eng., 2107 Green st., Philadelphia, Pa.
CLARKE, THOMAS C. ..... Lock Box No. 2, Philadelphia, Pa.
COOKE, ROBERT L. ..... Div. Eng. Dep't Public Parks, 36 Union sq. (East) New York.
COOPER, THEODORE ..... Care Am. Soc. Civil Eng's, 4 E. 23d st., New York.
CURTIS, WENDELL R. ..... Rockland, Mass.
DUBOIS, AUGUSTUS J. ..... Prof. Civil Eng., Lehigh University, Bethlehem, Pa.
EMONTS, WILLIAM A. G. ..... Care, Zahlmeister Emonts, Wurzburg, Germany.
FINK, ALBERT ..... 526 Broadway, Louisville, Ky.
FLINT, CHARLES R. ..... Care W. R. Grace & Co., 66 Pine st., New York.
FOGG, CHARLES E. ..... San Paulo, Brazil.
FORD, ARTHUR L. ..... 21 Clinton st., Brookyn, N. Y.
FORD, JAMES K. ..... 80 W. Sixth st., Oswego, N. Y.
HARLOW, JAMES H. ..... 22 Mt. Washington st., Lowell, Mass.
KNIGHT, WILLIAM B. ..... Care Am. Soc. Civil Engs., 4 E. 23d st., New York.
MOORE, ROBERT ..... 1118 St. Ange av., St. Louis, Mo.
MORRIS, MARSHALL ..... Sup't Jefferson Mines (Jefferson Co.), Ala.
OLNEY, LA FAYETTE ..... 145 Erie st., Buffalo, N. Y.
OPDYKE, STACY P., Jr. ..... Lewiston, Pa.
PETERSON, PETER A. ..... Cons. Eng., Toronto Water Works, Toronto, Canada.
ROSS, WILLIAM B. ..... Nashville, Tenn.
STRATTON, FRANKLIN A. ..... U. S. Navy Yard, League Island, Philadelphia, Pa.

RESIGNATIONS.

CURTIS, RUSSELL H.	Rock Island, Ill.	Nov. 14, 1876.
MCCLELLAN, GEORGE B.	New York.	" 28, "

American Society of Civil Engineers.

PROCEEDINGS.

Vol. II. December, 1876.

MINUTES OF MEETINGS.

(Abstract of such as may be of general interest to members.)

OF THE SOCIETY.

DECEMBER 6TH, 1876.—A regular meeting was held at 8 o'clock, P. M.

A paper, by Prof. Robert H. Thurston, of Hoboken, N. J., "On the Set and Decrease of Resistance of Metals subject to Distortion," was read and briefly discussed.

Messrs. George W. R. Bayley, Elmir L. Corthell, Caleb G. Forshey, Edward D. Frost and Charles W. Howell were appointed members resident in New Orleans, of Committee on Ninth Annual Convention; the remainder of the session was spent in conversation.

DECEMBER 20TH, 1876.—A stated meeting was held at 8 o'clock, P. M.

A paper, by Charles E. Emery, M. E., of New York, on "Connected segmental Marine Boilers, a Demonstration of the Principles of their Construction," was read; a discussion followed, and the remainder of the session was spent in conversation.

OF THE BOARD OF DIRECTION.

DECEMBER 6TH, 1876.—A stated meeting was held at 3 o'clock P. M.; proposals for admission to the Society were considered, appropriations made and other routine business done.

The following, presented at the Eighth Annual Convention, then referred to the Board, and duly presented at meeting held August 16th, was ordered to be submitted to the Society without comment, for vote by letter ballot:

Resolved, that the American Society of Civil Engineers will further, by all legitimate means, the adoption of the Metric Standards in the Office of Weights and Measures at Washington, as the sole authorized standards of weights and measures in the United States; that the Chair appoint a committee of five to report to the Society a form of memorial to Congress, in furtherance of the object expressed; and that the foregoing be submitted to the Society and voted on by letter ballot.

On recommendation of the Committee on Library, these rules for management of the Library were adopted :

1°. Books which are catalogued, shall not be taken from the rooms of the Society without the consent of the Library Committee, to whom written application must be made for such privilege.

2°. The following to be posted in the Library :—

I. No conversation is permitted in this room, except during the meetings of the Society.

II. Persons consulting books will not be permitted in any case to return them to the shelves.

The President and Secretary were requested to formally express to Mr. John B. Jervis, Honorary Member, the thanks of the Society for his valuable contribution of drawings, specifications and memoirs referring to early American engineering.

BOOK NOTES.

Iron Highway Bridges.*—The writer dedicates his book to "Town Committees, Selectmen, County Freeholders, and other public officers to whom is entrusted the responsibility of erecting Iron Bridges;" and in telling them what are the essential elements of a good bridge, he supplies them with a large amount of practical information that has hitherto been inaccessible to them. If he does not succeed in gaining their attention, it will not be for a lack of merit in his work. In undertaking to educate the average committeeman or Freeholder, Mr. Boller has addressed himself to a Herculean task; these gentlemen will continue to build as cheaply as the law will permit, and stringent laws alone will prevent the erection of unsafe highway bridges.

The author must be content with having produced a book which is very valuable and useful to the general engineer and to the young bridge engineer about entering upon the practice of his profession. If the former is not an expert in this branch of engineering, he will find here, written in a compact, clear, straightforward manner, exactly the hints and information he needs when suddenly called upon to examine bridge plans and specifications, or to act as inspector of bridges; the latter will look in vain in his text books for the practical knowledge that is here conveyed, and that is so necessary to him.

The distinctive physical properties of iron are fully pointed out, the qualities it should possess, and the tests to which it should be submitted, are described so that the inexperienced may judge; then, after a few words of sound advice about timber, the author describes the different kinds of bridges in general use, and in regard to the selection of a plan gives this advice, which is good for engineers as well as committeemen : "Ignore any plan of bridge that cannot be accurately analyzed as to the character and amount of strain occurring in all its parts."

There are some very sensible and timely remarks upon connections and upon the merits of the two systems of bridge building—the American and the European—showing how the former so greatly excels the latter, and why it has attained the noble position of being the best system, scientifically and practically, in the world. Struts or posts, eyes and eye-bars, pins and rivets with their sections, sizes and proportions, are fully treated of; while loads, roadways, sidewalks, pavements, in fact, everything pertaining to a highway bridge receives proper attention. Neither do the æsthetics of bridge construction fail of their share of consideration.

The second part of the book is devoted to the consideration of strains in girders and simple trusses, and very simple methods are given for finding them in the ordinary forms in use.

Altogether, the author has more than well fulfilled the task he allotted to himself, and given a large amount of valuable practical information obtainable from no other source.

* Practical Treatise on the Construction of Iron Highway Bridges for the Use of Town Committees, together with a short Essay upon the Application of the Principles of the Lever to a ready Analysis of the Strains upon the more customary Forms of Beams and Trusses. Alfred P. Boller, A. M., C. E., Member of the American Society of Civil Engineers. Wiley & Sons, New York, 1876.

LIST OF NEW BOOKS ON

ENGINEERING AND TECHNOLOGY.

Under this head will be announced new books on these and kindred subjects, which may be professionally useful to members of the Society.

Aerial Navigation, ed. by R. B. Mansfield, with Preface by J. M. Ludlow. London. 8vo. (*Van Nostrand. New York.*) $5.00.

Aquarium (the); its Inhabitants, Structure and Management. J. S. Taylor. London. 8vo. (*Van Nostrand. New York.*) $3.00.

Art in Ornament and Dress, trans. from the French of Charles Blanc. London. 8vo, illus. (*Scribner, Welford & Armstrong. New York.*) $3.75.

Botany. Wild Flowers of America. Part I; illus. by Isaac Sprague, text by George L. Goodale. Boston. 4to, illus. *Hurd & Houghton.* $5.00.

Brewing. Art of ——, practical and theoretical. Frank Faulkner. London. 8vo. (*Van Nostrand. New York.*) $5.00.

Bridges. Practical Treatise on the Properties of continuous ——. Charles Bender. New York. 16mo, illus. *Van Nostrand.* $0.50.

Bridge. The American —— Company's Album of Designs of Bridges, Roofs, Turn-Tables, Iron Trestles, pneumatic and Masonry Structures, &c. Chicago. 4to, illus.

Catalogue of Library of the Franklin Institute. Philadelphia. 8vo. *Frank. Inst.* $2.00.

Census of Massachusetts, 1875, prepared under Direction of Carroll D. Wright, Chief of Bureau of Statistics of Labor. Vol. I. Population and social Statistics. 1st ed. Boston. 8vo. *Wright.*

Chemical Analysis, (qualitative,) a Guide in the practical Study of Chemistry and in the Work of Analysis. S. H. Douglas and Albert B. Prescott. 2d ed., rev. Ann Arbor. 8vo. (*Van Nostrand. New York.*) $3.50.

Chemistry, a Course of practical ——, arranged for use of medical Students. Wm. Odling. 5th ed. London. 12mo, illus. (*Van Nostrand. New York.*) $3.00.

———. The combined Note Book and Lecture Notes for Use of chemical Students in organic Chemistry. London. 4to. (*Van Nostrand, New York.*) $1.75.

Civil Engineers. Minutes of Proceedings of the Institution of —— ——, with other selected and abstracted Papers. Vol. XLVI. Sessions 1875-6. Part IV. London. 8vo, illus. *Inst. Civil Eng.*

Decoration. Suggestions for House ——, in Painting, Wood-work and Furniture. Rhoda and Agnes Garrett. London. 12mo, illus. *Macmillan.* (*New York.*) $1.00.

Drawing. Krusi's industrial elementary Architecture. Charles Babcock. Ithaca. Folio, 8 nos. (*Appletons. New York.*) Each $0.50.

Elliptic Functions. Elementary Treatise on —— —— Arthur Cayley. London, 8vo. (*Van Nostrand. (New York.*) $7.50.

Excavation and Embankment. Formulæ for Calculation of Railroad —— ——. John W. Davis. New York. 8vo, illus. *Van Nostrand.* $1.00.

Etching, Examples of modern ——. New Series. 20 choice Etchings by Queroy, Brunet, Debaines, Hamerton, George, Burton, Wise, Legros, Lurat, Seymour, Hayden, etc., with descriptive Text by P. G. Hamerton. London. Folio. (*Bouton, New York.*) $12.00.

Exposition, a French View of the Grand International ——, 1876, being a graphic Description, with Criticisms and Remarks. L. Simonin, trans. by Samuel H. Needles. Philadelphia. 8vo. *Claxton.* $0.50.

Finance, an Alphabet in ——, a simple Statement of permanent Principles and their Application to Questions of the Day. Graham McAdam, with Introduction by R. R. Bowker. New York. 12mo. *Putnams.* $1.25.

Fire Protection, being a complete Manual of the Organization, Machinery, and general Working of the Fire Brigade of London. Eyre M. Shaw. London. 8vo, illus. (*Van Nostrand. New York.*) $6.25.

Gases, a Treatise on the kinetic Theory of ———. Henry W. Watson. London. 8vo. (*Van Nostrand, New York.*) $1.75.

Geological Survey of Indiana. Sixth and Seventh Annual Reports of ———, made during 1874-5. E. T. Coxe. Indianapolis. 8vo.

Geometry and Conic Sections, Manual of —— ——. Wm. G. Peck. New York. 12mo. *Barnes.* $1.60.

Insects, Half Hours with ——. A. S. Packard. (Recreations in Natural History). Boston. 12mo, illus. *Estes & Lauriet.* $2.50.

Insurance, a Digest of the Fire, Life, Marine, Accident, and Guarantee Insurance Cases decided in England, Ireland, Scotland, Canada, and the United States, from the earliest Period to 1876. O. B. Sansum. New York. 8vo. *Callaghan.* $8.00.

——— Cyclopedia; being a Dictionary of Definition of Terms used in Theory and Practice of Insurance in all its Branches, a biographical Summary of Lives of those who have contributed to the Development and Improvement of Theory and Practice of Insurance, &c.; also containing a detailed Account of Rise and Progress of Insurance in Europe and America. London. 8vo. Vols. I-III. (*Van Nostrand, New York.*) Each $9.00.

Jetty System, Report on —— ——, as applied to the Channel of Entrance to Cumberland Sound, Ga. Quincy A. Gilmore. New York. 8vo, illus. *Van Nostrand.*

Kinnematic Models. M. Kennedy. London. 12mo, illus. (*Van Nostrand, New York.*) $0.25.

Metal Work; Compendium of Architectural Sheet —— ——, embracing Rules and Directions for Estimates, Items of Cost, Nomenclature, Tables of Brackets, Modillions, Dentils, Trusses, Stock Blocks, Frieze Pieces, &c. Salem, Ohio. 8vo, illus. (*Van Nostrand, New York.*) $10.00.

Microscopic Science, a Compendium of ——— ; Micro-Mineralogy, Micro-Chemistry, Biology, Histology and Pathological Histology. J. H. Wythe. 3d ed., rev., rewritten, and enl. Philadelphia. 8vo, illus. *Lindsay & Blakiston.* [Announcement.)

Mississippi River. Report of a Commission upon the Works for the Improvement of the South Pass of —— ——, November 11th. 1876. Washington. 8vo, illus. *Gov't Printing Office.*

Music. Student's Hand-Book of the Science of ———. John Taylor. London. 8vo. (*Van Nostrand. New York.*) $3.00.

Natural History. Contributions to —— —— of the United States. Vol. V. Louis Agassiz. Plates. Boston. $6.00. (Announcement.)

Parliamentary Practice, Manual of ——. Rules for conducting Business in deliberative Bodies. P. H. Mell. New and rev. ed. New York. *Sheldon.* $0.75.

Philosophy. Outlines of Lectures on the History of ———. John J. Elmendorf. New York. 12mo. *Putnams.* $1.50.

Photography. M. Abney. London. 12mo, illus.. (*Van Nostrand, New York.*) $0.25.

Physiology, a Course of elementary practical ———. M. Foster and J. N. Langley. London. 8vo, illus. (*Van Nostrand, New York.*) $2.00.

Railroads. Fourth Annual Report of the Commissioners of ——, of State of Michigan for 1875. Lansing. 8vo.

Science in Sport made Philosophy in Earnest, being an Attempt to illustrate some elementary Principles of physical Knowledge by Means of Toys and Pastimes, ed. by Robert Routledge. London. 12mo, illus. *Routledge.* (*New York.*) $2.50.

Silver Ores, a practical Treatise on testing and working —. Charles H. Aaron. San Francisco. 12mo, illus. (*Van Nostrand, New York.*) $2.50.

Smithsonian Contributions to Knowledge—. Vol. XX. Winds of the Globe, or the Laws of atmospheric Circulation over the Surface of the Earth ; Joseph H. Coffin.—Vol. XXI. Statement and Exposition of certain Harmonies of the solar System. Stephen Alexander: General Intervals of planetary Motion; Simon Newcomb: Tables, Distribution and Variations of the atmospheric Temperature in the United States; Charles A. Schott. Washington. 4to. *Gov't. Printing Office.* (*Van Nostrand. New York.*) Each $12.00.

Strains, the Theory of transverse —— and its Application in the Construction of Buildings, including a full Discussion of the Theory and Construction of Floor Beams, Girders, Headers, Carriage Beams, Bridging, Rolled Iron Beams, Tubular Iron Girders, Cast Iron Girders, Framed Girders and Roof Trusses ; with Tables calculated and prepared expressly for this Work, of the Dimensions of Floor Beams, Headers and Rolled-Iron Beams ; and Tables showing Results of original Experiments on the tensile, transverse and compressive Strength of American Woods. Robert G. Hatfield. New York. 8vo, illus. *Wileys.* (Announcement.)

Sound and Music. W. H. Stone. London. 12mo, paper, illus. (*Van Nostrand. New York.*) $0.25.

Surveying Projections, and portable Instruments for the Use of the Cadet Midshipmen at the U. S. Naval Academy. Text-Book on ——. New York. 8vo, illus. (*Van Nostrand. New York.*) $2.00.

Technical Education. Discussions on — ——, at Washington Meeting of American Institute of Mining Engineers, February 22-3, and at Joint Meeting of American Society of Civil Engineers and American Institute of Mining Engineers, at Philadelphia, June 19-20, 1876. Philadelphia. 8vo.

War. Battles of the Revolution, with topographical Illustrations, and military and popular Criticisms. Henry B. Carrington. New York. 8vo. illus. (*Van Nostrand.*) $6.00.

Water Supply Engineering. A Treatise on Theory and Practice of Gathering and Storing Water for Power and domestic Use, the Clarification of Water, the Flow in Pipes and Canals, the Raising of Water by Power, and in the practical Construction of Reservoirs, Weirs, Dams, and of Pipe Systems for the Distribution of Water in Cities and Towns. John T. Fanning. New York. 8vo, illus. *Van Nostrand.* (Announcement.)

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DONATIONS ARE ACKNOWLEDGED AS FOLLOWS:

From J. C. Aldrich, New York:

Department of Public Parks. Proposals for Improving and Constructing Riverside Avenue, New York. (2 copies.)

From American Bridge Co., Chicago:

Album of Designs of Bridges, Roofs, Turn-Tables, Iron Trestles, pneumatic and Masonry Structures, &c. Chicago.

Charts of Bridges, Roofs and other Works, with Sections and Details. 28 Plates.

Descriptive Circular of American Bridge Co. and its Work.

Illustrations of Atchison, Boonville and Fall River Bridges, also of Exhibit at International Exhibition. 24 Photographs and 6 stereoscopic Views.

From S.S. Cobb, Lansing, Mich.:

Fourth Annual Report of Commissioners of Railroads of State of Michigan, for 1875. Lansing.

From Cornell University, Ithaca, N. Y.:

Cornell University Register and Catalogue, 1875-6. (Copies for distribution.)

From J. W. Davis, New York:

Formulæ for Calculation of Railroad Excavation and Embankment. New York. (2 copies.)

From S. Fleming, Montreal, Can.:

The Intercolonial Railway, a historical Sketch of its Inception, Location, Construction, &c. Montreal.

From Gen. Q. A. Gilmore, New York:
Report on the Jetty System, as applied to Channel of Entrance to Cumberland Sound, Ga. Q. A. Gillmore. New York.

From Gen. A. A. Humphreys, Chief of Engineers, Washington:
Report of Commission upon Works for Improvement of South Pass of Mississippi River. November 19, 1876. (Copies for distribution.)
Report of Inspection of Improvement of South Pass of Mississippi, showing Condition of the Works. August 17, 1876. C. B. Comstock. (Copies for distribution.)

From Institution of Civil Engineers, London:
Minutes of Proceedings, with other selected and abstracted Papers. Vol. XLVI. Part 4. Sessions 1875–6. London.

From the Institution of Mechanical Engineers, Birmingham;
Proceedings. July Meeting, 1876.

From Charles Latimer, Cleveland, O.:
Atlantic & Great Western R'y. Comparative Statement of Expenses in Engineering Department to August, 1876.

From G. Leverich, New York:
Official Catalogue. International Exhibition. Parts I, II, III, IV. Philadelphia.

From Charles L. McAlpine, New York:
Opinion of two eminent Civil Engineers on Rapid Transit. New York. (Several copies.)

From Mansfield Merriman, New Haven, Conn.:
Catalogue of Officers and Students of Yale College, 1876.

From H. Metcalf, Lieut. Ordnance Corps, U. S. A.:
Index to Catalogue of Ordnance Collection, U. S. A., at International Exhibition, 1876. Washington.

From P. Moneta, New York:
Hydraulics of great Rivers; the Parana, Urnguay and La Plata Estuary. J. J. Revy. London.

From North-of-England Institute of Mining Engineers:
Transactions. Vols. 18–25, 1868–9 to 1875–6. Newcastle-on-Tyne. 8 vols.

From W. A. Norton, New Haven, Conn.:
Results of Experiments on Contact Resistance. W. A. Norton. New Haven.

From George W. Pearsons, Oswego, N. Y.
Coffer Dam, from the Raft. 2 stereoscopic Views.

From J. W. Schwedler, Berlin:
Construction of Railway Bridge over the Weicksel at Thorn, after Designs of J. W. Schwedler and H. Loeffler. Berlin. 1876. (German.)

From E. N. K. Talcott, Morgan Park, Ill.:
Catalogue of Officers and Students of Morgan Park Military Academy, September 14th, 1876. Chicago.

From Miscellaneous Sources:
Building Gazette, published with Co-operation of Royal Technical Building Deputation and of Society of Architects of Berlin. Berlin. (German.)
Sixth and Seventh Annual Report of Geological Survey of Indiana. E. L. Coxe. 1874–5. Indianapolis.

ANNOUNCEMENTS.

MEETINGS OF THE SOCIETY for the next three months will be held as follows:—*regular* meetings, when ballots for members will be canvassed, and other business done, Wednesday, January 3d, February 7th, and March 7th; and *stated* meetings, for consideration of professional topics and enjoyment of social intercourse, Wednesday, January 17th, February 21st, and March 21st—each at 8 o'clock P. M.

MEETINGS OF THE BOARD OF DIRECTION during the same term for the transaction of regular business, will be held January 3d, February 7th, and March 7th, at 3 o'clock P. M.

PAPERS ON ENGINEERING SUBJECTS, giving results of practice, or in discussion of pertinent theoretical questions, are desired from members of the Society; their comments (whether or not present at meetings of the Society), upon papers published in Transactions, are solicited, and they are urged to contribute from note-books and other similar records, whatever may bear upon the subjects considered, or refer to other practical topics. A list of subjects relating to the practice of engineering and its connection with kindred art and public affairs, on which papers are desired, may be found on page 51, Vol. I.

ILLUSTRATIONS OF PAPERS presented for publication should be distinctly drawn in *broad, sharp* lines, upon *white, smooth* (not "egg" or enamelled) paper, with perfectly (not glossy or grey) *black* ink, to a scale twice or thrice greater than the print is to be; which in no case should require folding in more than one direction, (*i. e.*, the depth of plate, as inserted in Transactions, should not exceed 9 inches). Shades are to be produced by variations in size and spacing of *black* lines; no brush work or colors are admissible. Unless figures and letters can be *well* put in, simply pencil them, leaving the engraver to insert them in the plate. Always put a scale upon each drawing.

EXTRA COPIES.—A member may order 25 copies without charge, and as many more as desired at cost of paper and presswork, of

any paper he contributes, by giving notice to the Secretary of the number required—*before* the paper is printed.

METRIC SYSTEM OF WEIGHTS AND MEASURES.—By courtesy of the Standing Committee of the Boston Society of Civil Engineers on the Metric System, a copy of its recent report (December, 1876), has been sent to each member of this Society. Attention is called to the following note accompanying same :—

To the American Society of Civil Engineers. —One year ago we had the honor to address you on behalf of the Boston Society of Civil Engineers, requesting your co-operation in petitioning Congress for the adoption of the Metric System of Weights and Measures at some future time. Understanding that you are now about to take a vote on the question : "shall a Committee be appointed for the purpose" of eporting " to the Society a form of memorial to Congress in furtherance" of "the adoption of the Metric Standards in the Office of Weights and Measures at Washington, as the sole authorized standards of weights and measures in the United States," we hope you may be interested in our report which was recently presented to the Boston Society, and referred to the Government with authority to print. We invite especial attention to Art. 2, from which it appears that memorials of considerable variety of tenor are now before Congress.

Yours very respectfully,

FREDK. BROOKS, L. FREDK. RICE,
CLEMENS HERSCHEL,
Standing Committee on Metric System.

CURRENT VOLUMES of "Transactions" and "Proceedings," close with this issue. Title Page and Index for each will be published with the January number.

LIST OF MEMBERS.

ADDITION.

	Date of Election.
SCUPHAM, JOHN R.....As't Eng., Central Pacific R. R., San Francisco, Cal.....	October 4, 1876.

CHANGES AND CORRECTIONS.

ALBERT, JOHN S. .....Chf. Eng., U. S. Navy, 3713 Walnut st., Philadelphia, Pa.
ALDRICH, JAMES C.....Sup't'g Eng., Dept. Public Parks, 36 Union square (East), New York.
FALCONNET, EUGENE F.....Eng. and Supt., Duck River Valley R. R., Columbia, Tenn.
HOLLEY, ALEXANDER L.....American Exchange, 449 Strand, London, England.
HAMPTON, FREDERICK T...Loudon, Loudon Co., Tenn.
LOVETT, THOMAS D. .....Winton Place, Hamilton Co., O.
MILLINGTON, THOMAS H...Land Dept., Texas & Pacific Ry., Marshall, Texas.
NORTH, EDWARD P.....Fordham, N. Y.
PETTIT, HENRY .....1509 Walnut st., Philadelphia, Pa.
SELLERS, WILLIAM.....1819 Vine st., Philadelphia, Pa.
SCOVILL, E. TRACY.....20 Euclid av., Cleveland, O.

DECEASED.

BAYLEY, GEORGE W. R....Late of New Orleans, La.....December 14, 1876.

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DISCUSSIONS

ON

TECHNICAL EDUCATION,

AT THE WASHINGTON MEETING OF THE

AMERICAN INSTITUTE OF MINING ENGINEERS,

FEBRUARY 22d and 23d, 1876,

AND

AT A JOINT MEETING

OF THE

AMERICAN SOCIETY OF CIVIL ENGINEERS,

AND THE

AMERICAN INSTITUTE OF MINING ENGINEERS,

AT PHILADELPHIA, ON JUNE 19th and 20th, 1876.

NEW YORK:
PUBLISHED BY THE AMERICAN SOCIETY OF
CIVIL ENGINEERS.
1876.

PHILADELPHIA.
SHERMAN & CO., PRINTERS.

INTRODUCTION.

AT a time when the minds of engineers were ripe for the discussion of Technical Education, it needed but a presentation of the case before some prominent association of engineers, to call out a full and free expression of opinion regarding the defects of existing systems and the principles and methods of improvement.

At the Washington meeting of the American Institute of Mining Engineers, in February last, the President's opening address presented the subject in certain aspects, which had the effect of stimulating discussion from the "practical" side and from the scholastic side of the profession. An interesting debate sprang up, but, as the prescribed business of the meeting did not permit time nor preparation for the suitable consideration of the subject, the Council of the Institute, upon motion of Mr. Eckley B. Coxe, appointed a committee to confer with the American Society of Civil Engineers, for the purpose of arranging a joint discussion on Technical Education, by members of both societies, during the period of their summer meetings in Philadelphia. The Board of Direction of the American Society of Civil Engineers at once appointed a similar committee.

JOINT COMMITTEE.

HENRY R. WORTHINGTON, Prest., Member Am. Soc. C. E.
THOMAS C. CLARKE, Member Am. Soc. C. E.
CHARLES BENDER, Member Am. Soc. C. E. and Inst. M. E.
ECKLEY B. COXE, Member Inst. M. E.
ROSSITER W. RAYMOND, Member Inst. M. E.
ALEXANDER L. HOLLEY, Sec., Member Inst. M. E. and Am. Soc. C. E.

The Joint Committee issued the following circular:

"At a meeting of the Joint Committee of the AMERICAN SOCIETY OF CIVIL ENGINEERS and the AMERICAN INSTITUTE OF MINING ENGINEERS on TECHNICAL EDUCATION, held in New York on March 17th, 1876, it was

'*Resolved*, That the Secretary of the Joint Committee be authorized to transmit the following request to such members of the two societies represented, and to such foreign engineers as the Committee may designate:

'You are hereby requested by the Joint Committee of the American Society of Civil Engineers and the Institute of Mining Engineers on Technical Education, to discuss this subject at a joint meeting of the two societies, to be held on June 20th, during their Philadelphia meetings, the discussion to be chiefly upon the following questions:

'I. Should a course of instruction in works precede, accompany, or follow that in the technical school?

'II. Is it practicable to organize practical schools, under the direction and discipline of experts, in engineering works?

'For the purpose of explaining more fully the nature and scope of these questions, an abstract of the remarks made on the subject at the February meeting of the Institute of Mining Engineers is herewith sent you.

'As it is believed that a number of foreign engineers, as well as many of our own experts, will wish to take part in this discussion, the time of each speaker will be limited to ten minutes, until after all on the list have spoken, but any reports or considerations on Technical Education which may be presented to the meeting in writing will be printed with the proceedings.

'Please give early notice if you will take part in the discussion.

'A. L. HOLLEY,
'Secretary.'"

This circular was sent to several prominent engineers, foreign and resident, who were not members of either society, and to a number of such members of the two societies as would probably represent

the widest range of experience and opinion. Of these, nearly all expressed a desire, and the greater part an intention, to join in the discussion; of the latter, some were finally prevented, by various causes, from carrying out this intention. A few gentlemen took no notice of the invitation. More than half those applied to, took part in the debate or they furnished papers.

The Joint Committee direct that the address of the President of the Mining Engineers, and the debate thereon at Washington, which are in fact a part of the same discussion, shall be affixed to the record of the joint discussion, so that the whole matter may be presented consecutively and in order.

A. L. HOLLEY,
Secretary of the Joint Committee.

NEW YORK, Oct. 1, 1876.

ADDRESS OF PRESIDENT A. L. HOLLEY,

BEFORE THE

AMERICAN INSTITUTE OF MINING ENGINEERS, AT WASHINGTON, FEB. 22d, 1876,

ON THE

INADEQUATE UNION OF ENGINEERING SCIENCE AND ART.

THE application of scientific methods to the investigation of natural laws and to the conduct of the useful arts which are founded upon them, is year by year mitigating the asperity and enlarging the outcome of human endeavor. More notably, perhaps, are these the facts in that system of productive and constructive arts of which engineering is the general name. In metallurgical engineering especially, within the period of our own recollection, how rapid has been the rate and how wide the scope of progress: the scientific discovery and mining of metalliferous veins; the economical separation and reduction of ores of every grade; the production and regulation of high temperatures; the varied improvements in the manufacture of iron, in saved heat and work, in uniformity and range of products; and, most important of all, the creation and the utilization, to be counted by the million tons a year, of the cheap constructive steels.

Wonderful as this range and degree of development may appear to the public eye, the close and thoughtful observer must, nevertheless, conclude that neither the profession nor the craft of engineering may congratulate themselves too complaisantly, but that they should rather acknowledge to each other the embarrassing incompleteness of the union between engineering science and art.

There is a small school of philosophers whom we may designate as original investigators, men who come close to nature, who search into first principles, and who follow that scientific and therefore fruitful method by which the relations of matter and force are discovered, classified, and brought within the reach of practice. These wonderful men do not indeed create the laws of nature, as they sometimes almost seem to, but they go up into the trembling mountain and the thick darkness and bring down the tables upon which they are written.

There is a larger class of men whom we may designate as the schoolmen; they are learned in the researches and conclusions of others, and skilled in reasoning or speculating from these or from abstract data upon the certain or probable results of physical and chemical combinations.

And there is the great army of practicians, almost infinite in its degrees of quality, ranging from the mere human mechanism by which mind lays hold of matter and force, through all the grades of practical judgment and power.

Let us first consider the matter from the "practical" man's standpoint. Every day's experience teaches him that the men who speculate, from secondhand data, upon the probable results of combinations of forces and materials, are not the men who can best make these combinations in practice, who intuitively know all the concealed pitfalls, such as friction, that trick of nature which like the thousandth part of phosphorus, alters all the conditions of use in iron; nor are they the men who can determine the completeness of these combinations, or read the record of their results, as in the character of a flame, in the feeling of a refractory mixture, in the behavior of a metal under treatment; nor are they the men who, by familiarity with objects and phenomena, are best fitted to pursue that original investigation which is the foundation of even theoretical progress. The expert who delights to call himself "practical," is honestly amazed at the attempts of experts by school graduation, who have not been graduated in works, to solve the engineering problems of the day. And from his standpoint there are numerous and conspicuous illustrations. While metallurgists are still disputing over the nature and sequence of reactions in combustion and reduction, the practical ironsmelter has felt his way from the barbarous practice of a century ago, to the vast and economical production of to-day. The attainment of powerful and sufficiently hot blast by means of waste heat, the adaptation of shape and proportion of stack to different fuels and ores, labor-saving appliances and arrangements,—all these have grown out of the constant handling, not of books, but of furnaces.

Proceeding upon a chemical knowledge little superior to that of the average schoolboy, Bessemer developed his revolutionary process. Not knowing for years that the combustion of silicon or of manganese are the chief sources of the necessary heat; ignoring the fact that not alone the reaction but the presence of manganese is a cause of soundness and malleability in steel; magnifying the hypothesis

that silicon should promote soundness; instructing his licensees to avoid all irons containing above 0.02 per cent. of phosphorus; and sharing the ignorance of the whole metallurgical profession as to the sequence of reactions in the converter and the probability of changing their character, Bessemer and his followers, during the first fifteen years of their practice, nevertheless brought this difficult art, which the metallurgical schools call a chemical art, to a high degree of commercial success, and this in the absence of any metallurgical change or chemical improvement whatever, in the treatment of the metal. During all this time, there was almost no literature of the Bessemer manufacture, and no instructor save that grim sphinx the converter and the well-nigh inscrutable process. It was a hand-to-hand fight, involving mechanical details, refractory linings, celerity of operations, regularity of melting and conversion and economy of labor. With every fact written in his book, the closeted scientist could no more adequately prescribe the practical conditions of improvement, than could the student in optics specify in words and formulæ the glory of an Italian sunset.

Here is a cupola-furnace, an old and exceedingly simple device; but one may know all the laws of combustion and fluxing that are written in the cyclopedias, and yet fail to change its working at will, or fail to detect the coming change, until by long familiarity, the phenomena reveal themselves as it were instinctively. One may have learned every law of the reactions of oxides and fluxes upon a refractory material, yet until his practiced hand and eye and ear can nicely detect its physical qualities and measure the results of new ingredients and temperatures, he may wander for years in a maze of uncertainties. Notwithstanding all our previous knowledge about the inevitable combustion of carbon and oxygen in the presence of heat enough to ignite them, the Siemens-Martin process, both in its calorific and in its metallurgical aspects, was as purely unpractical as the direct utilization of sun-heat is to-day, until after years of patient observation, not chiefly by scientists but by men unacquainted with books and knowing nothing at second-hand, innumerable small increments of improvement at last produced a sufficient temperature in a durable furnace.

In the development of machinery, the same history is repeated. The proportions of parts, in fact, the modern formulæ themselves, are derived from the study of innumerable experiments. The adaptation of machinery can only be perfected by him who, as it were, enters into it, making it an incarnation of himself. This enlarge-

ment of a man's organism is most strikingly illustrated in the locomotive. Oliver Wendell Holmes has happily described this putting of his life into his "shell" boat, his every volition extending as perfectly into his oars as if his spinal cord ran down the centre of its keel, and the nerves of his arms tingling in the oar-blades. The thoughtful locomotive-driver is clothed upon, not with the mere machinery of a larger organism, but with all the attributes of a *power* superior to his own, except volition. Every faculty is stimulated and every sense exalted. An unusual sound amid the roaring exhaust and the clattering wheels tells him instantly the place and degree of danger, as would a pain in his own flesh. The consciousness of a certain jarring of the foot-plate, a chattering of a valve-stem, a halt in the exhaust, a peculiar smell of burning, a sudden pounding of the piston, an ominous wheeze of the blast, a hissing of a water-gauge—warning him respectively of a broken spring-hanger, a cutting valve, a slipped eccentric, a hot journal, the priming of the boiler, high water, low water, or failing steam—these sensations, as it were, of his outer body, become so intermingled with the sensations of his inner body, that this wheeled and fire-feeding man feels rather than perceives the varying stresses upon his mighty organism.

Mere familiarity with steam-engines is not, indeed, a *cause* of improved steam-engineering, but it is a *condition*. The mechanical laws of heat were not developed in an engine-house, yet without the mechanism which the knowledge derived *through this familiarity* has created and adapted, the study of heat would have been an ornamental rather than a useful pursuit. So in other departments. When one can feel the completion of a Bessemer "blow" without looking at the flame, or number the remaining minutes of a Martin steel charge from the bubbling of the bath, or foretell the changes in the working of a blast-furnace by watching the colors and structure of the slag, or note the carburization of steel by examining its fracture, or say what an ore will yield from its appearance and weight in the hand, or predict the lifetime of a machine by feeling its pulse; when one in any art can make a diagnosis by looking the patient in the face rather than by reading about similar cases in a book, then only may he hope to practically apply such improvements as theory may suggest, or to lead in those original investigations upon which successful theories shall be founded.

These are the conclusions of the "practical" man, and they are none the less true because they are not the whole truth. That they

are too little considered by the schoolmen and the graduates of schools is also true, but happily, less conspicuously so as the years advance.

The evil consequences of this mistake develop themselves in various ways. The recent graduates of schools do not, indeed, expect immediate positions of responsibility and authority, but they often demand them after too short a term of object-teaching. Perhaps the greatest advantage of their scientific training is that they can learn from objects and phenomena faster than can the mere workman, who, although full of the elements of new and useful conclusions, lacks, if I may so say, the scientific reagent which precipitates the rubbish and leaves a clear solution of the problem. It is however true—in the iron manufacture, perhaps, especially true—that men of wide learning and of great mental dexterity, unless they have studied at least as many years in the works as they have in the school, do not successfully compete for the desirable places with the men who have come up from the ranks. Narrow, unsystematic, and fruitless of new results as his knowledge may be, he who has grown up steadily from the position even of puddler's helper, will be selected to take the manager's post in preference to him whose reputation is founded solely on the school.

Nor does this prove, as the schoolmen too often believe, that the owners and directors of metallurgical enterprises are generally unappreciative of scientific culture. It rather proves that the lowest functions, as in the case of poor humanity, must first be considered; that the conditions of maintenance and regular working, which constant familiarity with objects and phenomena alone can provide, are earliest in order. Conservation first and improvement afterwards.

Another consideration in this connection is that scientific aid appears to be more readily provided for the "practical" man than practical aid for the "scientific" man. The trained scholar can the more readily adapt himself to the situation. He should suggest many more improvements than would ever crystallize in an equally good but undisciplined mind. Yet his attempt, with mere scholastic aids, to carry these improvements out, might disorganize a whole establishment. As there must be one final authority, judgment founded on experience almost universally ranks the wider and more fruitful culture of the school. And if we ask those great masters whose experimental knowledge is as wide as their scientific culture, they will tell us, that as the inert and clumsy flywheel, that typical conservator, is more helpful to a steam-engine in the long run, than a valve-gear so highly organized that it seems to know what it ought to

do, so in their own undertakings, plodding, practical economics must sit in judgment upon theory and limit the reaches of imagination.

Another evil growing out of the inadequate regard of mere schoolmen for practice, is the frequent failure of their works or their inability to complete them. Inventions and constructions, designed after a scientific method and under the light of organized facts and detailed history as laid down in books, may fail simply in default of a practical knowledge of how far the capital at hand will reach, or what the means at hand will do, or what the materials at hand will stand, or what the labor and assistance at hand can be relied on to accomplish. A vast number of facts about the operation of forces in materials are so subtle, or so incompletely disentangled from groups of phenomena, that they cannot be defined in words, nor understood if they could be formulated. But after long familiarity with the general behavior of materials under stress, a practical expert can, by a process more like instinct than reason, judge how far and in what directions he may safely push his new combinations. Thus while the unschooled practician so usually wastes his energies in unscientific methods and on impossible combinations, but generally carries into successful use his comparatively few well-founded attempts, the student merely of principles and abstract facts so usually originates the ideas upon which progress is founded, and so rarely clothes them with practical bodies. In this chasm between science and art, how much effort and treasure, and even life, are swallowed up year by year.

These are not theoretical considerations. The blast-furnace, the converter, and the open-hearth have already been referred to; let us observe some other illustrations. A bridge-builder will tell us that few structures in his department of engineering fail by reason of mistakes in calculating the strain-sheet, but that the majority of failures arise from vibrations, buckling, rapid wear of important parts, shapes that weaken the material, inequalities in the material, and similar causes which are not stated in books, which assume different aspects under every change of proportions and dimensions, and which can only be inferred by means of a long familiarity with the behavior of similar structures during varying periods of service, and with the processes by which materials and members are fabricated. The builder of a machine like a marine engine, or a locomotive, or a roll-train, or a steam-hammer, will tell us that, in designing new adaptations, after every stress that can be distinctly analyzed is provided for, mass to resist vibration, changes of shape

to insure sound casting, and various modifications which cannot be formulated for the want of even approximately complete knowledge of their conditions, must still be supplied, simply by judgment founded on long observation of phenomena under similar conditions. And he will thus explain nine-tenths of the failures. Who can imagine the volume of a book, or of an author, which should adequately teach the principles of construction as affected by the chiefest of all practical considerations—the economies of the foundry, the forge, and the machine-shop? With the tools and facilities at hand, what divisions of a particular structure, what shapes and sizes and methods of joining can be made cheaply as well as strong and efficient, in all the infinite forms of mechanism? Obtaining such facts from any other source than personal practice, would be like an oarsman studying a book to know when and how in the race he must husband his power, or like a wrestler looking out in a cyclopedia the probable feints of his antagonist. The successful constructor will assure us that no possible training in the school, nor any genius in invention can build economically without such a knowledge of the shop as the athlete has of the possibilities of muscular strength and agility.

These arts have been selected as examples, not because they chiefly depend on skill, but because they so largely involve the highest formulated mathematical knowledge. How much more important, then, is practical training in those departments where physical laws are very incompletely understood and formulated. How far short of practical success will abstract science stop in sinking pneumatic piles through wrecks and boulders, in tunnelling rocks traversed by subterranean streams and beds of quicksand, in cheaply applying hoisting, ventilating and draining machinery to mines where the scene and conditions of operation are constantly shifting, in firmly founding heavy and vibrating machinery on treacherous ground, in handling and casting melted steel, in constructing refractory metallurgical vessels, in delivering bars red-hot and crooked in infinite directions to a roll train, in fabricating durable breech-loading cannon, in building boilers that shall provide for vaporization, circulation, separation, cleaning and durability, in designing enginery like the horseshoe machine to shape metals, in proportioning gas-furnaces, in submarine warfare, in aerial navigation, in machine tools, in traction engines, in scaffolding and erection, in railway running-gear, in forming artificial stone under water, in permanent way, in coal-cutting, in dredging machinery, in moulding and casting,

in brick machinery, in tube-drawing, in coal-burning, in pavements? Limited or impossible as would be the progress of engineering arts in the absence of that knowledge and those methods which are imparted in schools, delay and failure would hardly be less conspicuous if the schoolmen should stay in the schools and thence attempt the application of abstract science, or expect mere workmen to apply it by hearkening to their directions.

I hope it may not seem that the dignity of abstract scientific investigation is undervalued by the utilizers of nature's powers and materials, or that any considerations of profit obscure, even in the average commercial mind, the splendor of those achievements made in the mere love of truth, with thought of neither commercial application nor pecuniary reward—achievements which distinguish such names as Faraday, Bunsen, Leverrier, Mayer, Joule, Henry, Darwin, and Tyndall. Do not their successes rather encourage us, in our lower sphere, to more persistently pursue the method of these great discoverers—the original investigation of Nature's truths? Not less literally than in the poet's fancy,

> "To him who in the love of Nature holds
> Communion with her visible forms, she speaks
> A various language."

To the skilled artisan she reveals herself as truly though not as widely as to the philosopher. In the aphorism of Goethe, "Mankind dwell in her and she in them. With all men she plays a game for love, and rejoices the more they win."

But the undervaluation of the study of objects and phenomena by schoolmen, is not the principal hindrance to the complete union of science and art. A greater obstacle is the combined misapprehension and ignorance on the part of a large class of "practical" men, of what they are pleased to call "theory," meaning by theory, something which is likely to be discordant with fact—or possibly with the interests of the craft. We can hardly complain that their objection is ill-grounded, as far as it is grounded upon the practice of theoretical men; but the world has a right to complain of their narrowness of observation, of their stolid incomprehension of the results of science, of that pride of ignorance, of that bigotry, of that positive fear of the diffusion of knowledge, which is the normal condition of those who range only within the sphere of their own practice, and to whom analysis and generalization, in their business affairs, as well as in morals and politics, are an unknown thing. It is unfortunately true that a large number of managers in metallur-

gical enterprises—men who are deemed indispensable, and who probably, are indispensable, in the average state of practical science, are thus not incorrectly characterized. Conscious of their power as conservators, ignorant of the elements of improvement, and not unfrequently jealous and blindly fearful for the interests of their craft, they sit triumphant on an eminence (the steady undermining of which they cannot observe), and sneer at the too frequently condescending magniloquence of recent graduates and book men. The best of this class are the workful and painstaking men who come up from the ranks—men who are plucky in emergencies and regulative of labor—men whose unconscious reasoning or intuition covers the ordinary exigencies, and who, perhaps for this very reason, never inform themselves outside of their own range of observation, nor observe in a methodical or fruitful manner.

There is also a class of practicians who do secretly and abstractly respect the labors of the scientific investigator, and are unwillingly governed, more or less, by his conclusions; but their minds are so barren of general facts and so untrained in the scientific methods of utilizing facts, and hence so distrustful of any ideas which reach beyond their own practice, that they also are impediments rather than helpers in the union of science and art.

It is often said, I am aware, that there is never any real antagonism between science and art, and that all men respect, even if they do not promote, the efforts of both scientists and practicians to forward the useful arts. What then shall we say of that phase of trades-unionism, which not only tends to repress improvement, but which often violently defeats the works of progressive thinkers and sometimes destroys their authors? Let us also observe an extreme, but not isolated case of the executive treatment of science. Long before the professional career of most of us began, the Erie Railway Company commenced a series of experiments in civil and mechanical engineering, sometimes elaborate, like those of Zerah Colburn on traction, and always useful; many of them incorporated with and improving the practice of the road for a quarter of a century. The voluminous drawings and records of this experimental practice, always preserved by the engineers of the road, were just beginning to be remembered by young and inquiring engineers, as a mine of professional information, when it was discovered—you will hardly believe me—that the engineer of the Erie road having been turned out, the whole of this priceless accumulation of reports and drawings was dragged off by the cartload to a paper mill, and destroyed.

by James Fisk, Jr. In reviewing the railway history of the country, many of you will remember that this act of vandalism has been by no means the worst blow which engineering has received from so-called "practical" men.

I have referred to these exceptional cases, merely to correct a modern idea that engineering progress, especially by scientific methods, is as yet, the creature of popular favor. It is refreshing to turn from such considerations to the still exceptional but happily growing appreciation and helpful respect of practitioners and scientists for each other, as sometimes exemplified in the various departments of mining engineering. When we see recent graduates patiently leading the untrained, confused, but determined mind of the workman, painfully wrestling with hard names and occult processes, into methodical habits of thought and the rudiments of organized knowledge; when we see the grimy workman, not standing aloof for fear of his craft or of his trades-master, but dragging the recent graduate into mines and furnaces, and patiently teaching him how to recognize that matter, in mass and under mighty forces, which he had heretofore contemplated in cabinet specimens, and chiefly in ideas; when we see the commercial manager of metallurgical enterprises opening his works to the graduates of schools, and giving them a chance, not only to complete their education, but, by judicious application of their efforts, to earn a living meanwhile; when we see such things, as happily we may, here and there in metallurgical works, we may assure ourselves that *one* way has been discovered to promote the union of science and art.

In the enlargement of this method of mutual respect and instruction, to a certain extent lies the solution of the problem under consideration; but it is a complex method, only actively operative under several important conditions, such as:

1. A *public opinion* among schoolmen that a course of object and phenomena study in works is to be reckoned, not as a matter of mere business sequence, but as a large and equal feature of that curriculum which is essential to a degree of professional graduation.

2. A diffusion, among the class which we have termed the "practical" class, of a real appreciation of an organized system of information and of the scientific method of making this information useful to all classes of men and noxious or unimportant to none; such a general explanation to that vast, preponderating class of workmen and of foremen and managers, who are foremen and managers simply because they have been efficient workmen, as will

ever prevent their indiscriminate and contemptuous application of the term "theory" to whatever a schoolman proposes.

3. An understanding among the owners, directors and commercial managers of engineering enterprises, that it is not a matter of favor, but a matter of as much interest to themselves as to any class, that young men of suitable ability and of suitable preliminary culture, however acquired, should have opportunity and encouragement to master the practical features of technical education in works, not as mere apprentices, but under reasonable facilities for economy of time and completeness of research.

But these conditions do not largely exist, and are only growing with general civilization. They must be hastened and magnified by some better means than merely stating the case again and again, as some of us, I confess, are too fond of doing; than perpetually repeating, in a manner more sentimental than efficient, that scientists should appreciate practice, and practicians should appreciate science, and capital should join the hands of science and practice, saying: "Bless you, my children," in the expectation that this will prove a fruitful union. Let us rather inquire if some new order of procedure in *technical education*, some revolutionary innovation, if need be, will not put the coming race of engineers on a plane which is lifted above the embarrassments from which we are slowly emerging.

1st. In order that the technical school should be in the highest degree useful, fruitful, and economical, it must instruct, not *men* of good general education, but *artisans* of good general education. The art must precede the science. The man must first feel the necessity, and know the directions of a larger knowledge, and then he will master it through and through. Mark how rapidly the more capable and ambitious of practical men advance in knowledge derivable from books, as compared with the progress of bookmen, either in books or in practice. Many men have acquired a more useful knowledge of chemistry, in the spare evenings of a year, than the average graduate has compassed during his whole course. These men realized that success was hanging on their better knowledge. Familiar with every changing look of objects and phenomena, they detected the constant play of the unknown forces which underlie them, and longed for a guide to their operation, as a mariner longs for a beacon light. This practical familiarity and judgment at once revealed the importance of scientific facts and methods, promoted their acquisition, and guided their application. Under what com-

parative facilities does the mere recitation-room student, or even the mere analyst of the hundred bottles, study applied chemistry? It is to these a matter of routine duty, without a soul; they are neither stimulated nor directed by a previously created want. Beginning with theoretical and abstract knowledge, is no less an inverted process in the useful arts than in the fine arts; as it would be to take a course of Ruskin within brick walls, as preparatory to opening a studio, and then climbing the mountains to square nature with the book.

Undoubtedly there may be extremes in any form of educational method. For a youth to begin the special business of technical education by any method, practical or otherwise, before he has acquired not only a common school education, but, at least such a knowledge of polite literature and general science, including of course mathematics, as would fit him to enter one of the classical colleges, should be strongly discouraged, for various reasons. It is useless to disguise the fact that the want, not of high scholarship, but of liberal and general education, is to-day the greatest of all the embarrassments which the majority of engineering experts and managers encounter. This statement cannot be deemed uncomplimentary to the class, seeing that they have risen to power despite the embarrassment. At the present day, the high-school systems founded by States and by private enterprise, bring such an education within the reach of every one; and it seems of the first importance to promote, if not almost to create, a public opinion, that liberal and general culture is as high an element of success in engineering as it is in any profession or calling.

But this is not all. Professional and business success are not, even in America, the chief end of life. All the social and political relations, and even personal happiness, are governed, not by the specialties, but by the balance of mental culture. What, then, shall we say of the policy of wealthy parents—not indeed general, but too frequent—of placing an uncultured boy in a technical school and then in works and business, without giving him one chance to acquire a general and polite culture?

Many young men display a liking, and others a marked talent, in some special direction. There is no danger that these will be crowded out of existence by the culture necessary to make a well-balanced mind; and the nearer the talent approaches genius, the less imminent will be any such danger.

The proposition then is, not that mere common school-boys shall

go into works and then into technical schools, but that young men of more advanced general culture, when they do begin the business of technical education, shall apply to Nature first and to the schoolmaster afterwards.

It may be urged in favor of beginning in the technical school, rather than in the works, that mental capacity for the after acquisition and application of facts and principles is thus developed. But mental training is not the product of the technical school alone. Habits of logical thinking and power of analysis and generalization may be acquired in any school. And a positive objection to beginning with the technical school is, that it cannot stop at logical methods and sciences which are essentially abstract. It also attempts to teach about objects and phenomena, the first knowledge of which, if it is to be broad and genuine, must come from the fountain-head.

These considerations may be farther illustrated by the course of the inexpert graduate when he enters works as a matter of business or of study. We have seen that the practical man can, at least, keep the wheels running and the fires burning, and that when he is of a certain grade of ability and ambition, he will most rapidly acquire the scientific knowledge and culture which, joined to his practical judgment, make him a master. The unpracticed graduate, however, can keep neither wheels turning nor fires burning; he has not even the capacity of a conservator. Nor can he for a long time recognize, in the whirl and heat of full-sized practice, the course and movement of those forces about which his abstract knowledge may be profound. The youngest apprentices are more useful in an emergency. He must begin with the lowest manual processes, not indeed to become simply dexterous, but, as it were, to learn the alphabet of a new language. He has started in the middle of his course instead of at the beginning. He must go back before he can advance, while the practician goes straight on. The knowledge of the schoolman about physical science, however often he may have visited works and mines and engines during school excursions, is essentially abstract; it no more stimulates desire and power of practical research than the calculus creates a passion or a capacity for studying the actual work of steam in an engine, or the actual endurance of a truss in a bridge.

The disappointment of inexpert graduates at finding themselves so far from being experts, their inability ofttimes to pay for farther schooling, the necessity that they should now begin to earn money, as they had persuaded themselves they could so readily do upon graduation, discourage many from pursuing engineering, and, what

is worse, send many out into practice who never do complete their technical education, but who, by the character of their work, lower the professional standard.

It can hardly be urged against the precedence of practical culture, that the student will get "out of practice" while he is in the school. He may, indeed, lose dexterity, but not the better fruits of experience. In fact, those who begin as practicians, almost instinctively keep up their intimacy with the current practice.

A most signal advantage of beginning technical education in the works is, that the mind is brought into early and intimate consideration of those great elements of success which cannot be imparted in any other way,—the management of labor and the general principles of economy in construction, maintenance, and working. *An early knowledge of these subjects moulds the whole character of subsequent education and practice.* There seems to be no corresponding advantage in beginning with the technical school. The fundamental mathematics and general information on physical science may be acquired in the preliminary school.

There is little doubt that the managers of technical schools will favor this order of study. They want to graduate, not half-educated men, but experts. They desire, of all qualifications in the student, that enthusiasm which can only spring from a well-defined want of specific knowledge.

2d. But the *order* of education is not the only desirable change. Whether before or after their course in the school, the hundreds of young men who are every year entering engineering pursuits, are wasting their time in bad methods of practical study, or, if after the school course, they are more frequently doing bad work as engineers, when they should still be only students. Hardly two engineers acquire any part of their practical knowledge in the same curriculum. They pick it up as best they may, usually in a manner that is wasteful of time or damaging to the public. While the teaching of general facts and principles and of scientific method is highly developed, there is no organized system for guiding students to direct knowledge of objects and phenomena. This statement requires two explanations: I. Apprenticeship is a school of skill in a specialty rather than a school of liberal art. It is intended for a class of men who propose to remain mere workmen, and not for the class who intend to improve and direct engineering enterprises. It imparts a degree of dexterity far beyond the requirements of the general expert, while it would hardly impart in a lifetime his required range

of practical knowledge. II. A school of engineering practice, such as that of research in zoology which was established by Agassiz, would be wholly impracticable, because it could be nothing less than a vast and successful establishment for construction and operation in nearly all the departments of engineering. If such a school were not commercially successful, and if its range were not comprehensive, it would be unsuitable and inadequate.

Now, if there can be a *system* of instruction in the one school, there can be in the other. The same discipline and responsibility, the same guidance as to precedence of study, quality of evidence, and correctness of conclusion, should hold good in both cases. To say otherwise would be to say that *all* knowledge should come from unaided original research, and that every investigator should begin, not where a former investigator left off, but where he began. It therefore appears that there can be a school of practical engineering, but that it cannot be mere apprenticeship in engineering practice, nor a system of engineering construction and operation, maintained merely for the purposes of a school.

The only alternative is to establish organized schools in the various existing engineering works. At first, this idea would seem subversive of all discipline and economy, but I am assured by experts in several branches of engineering, that such would not be the case. Let us take, for example, a Bessemer works. A score of students under the discipline, as well as under the technical guidance of a master, could be distributed among its various departments, not only without detriment, but with some immediate advantage to the owner, for while receiving no pay, they would become skilful, at least as soon as the common laborers who form the usual reinforcements. Students should, of course, be expected, not to work when and in what manner they might choose, but to do good and full work during specific hours. This responsibility as workmen, would rapidly impart not only the knowledge sought in the works, but a desire for higher knowledge and culture.

These considerations are not merely theoretical. Several students at a time, subjected to no discipline, sometimes working hard, and sometimes not at all, may often be found in a Bessemer works, and I have yet to hear of their embarrassing the management in any way. The laborer has no cause for interference, as the students are not under pay, and whatever they accomplish is clear gain to the three parties concerned,—the owner, the student, and the operative. A large number of young men may be found studying in machine

shops, and sometimes earning small pay, besides having opportunity to work in all departments.

The proposition is to enlarge and systematize the existing desultory study in works—to increase its usefulness to the student, and, at the same time, to make the granting of such facilities to students an object, immediately, as well as remotely, to the owners of works. To this end, the schoolmaster should be not only well read in the professional literature, but a practical expert who could take charge of the works himself, so that whilst best aiding the students, he could prevent their interference with the regular and economical operations. His functions would be, not those of an instructor, nor, to any great extent, of a clinical lecturer, but those of a disciplinarian. The students should acquire skill, in order that they might acquire judgment of skill and original knowledge of materials and forces, and the master should see that they did acquire them all. He might do some service by stated examination and current criticism and suggestion, but his chief office would be to promote honest work, and to provide opportunity for work in all departments with reference to the economy of the student's time and to the owner's interests.

It should thus appear that these somewhat radical changes in the curriculum of engineering study—first, a hand-to-hand knowledge, acquired not desultorily, but by an organized system, and afterwards the investigation of abstract and general facts and their relations, would largely economize the student's time and better the quality of his knowledge. The novice is nearly as valuable a student in works as the graduate, but he is a vastly less apt scholar in the school. My own belief, founded on the study of many typical cases, is, that this order of procedure would produce a better class of experts in little more than half the time required by the reverse order; that it would always make *experts;* that it would discourage none from finishing an engineering education which would be complete in its parts, even if insufficient time were taken to fully develop it. A well-balanced culture will naturally grow in scope and in fruitfulness.

In this connection it seems proper to say a word about the royal road to learning, which a few ill-advised students attempt to pursue I do not refer to their availing themselves of professional data and drawings on file in engineering offices, but I do refer to their asking engineers and managers to furnish them special reports on subjects regarding which their own observation would be vastly more useful to the applicants, and quite as convenient to the respon-

dents—reports on the number and duties of workmen in each department, and the particulars of operation and relative cost, which can only be profitably investigated by a student, when not only the facts but the reasons are ferretted out by himself, rather than transmitted to the academic grove through the post office.

In conclusion, if it should appear upon larger observation, to the profession in general, as it does appear to many of its members, that this want of coalescence, ranging from indifference to antagonism between its scientific and practical branches, is a real and substantial fact, a larger effort would undoubtedly be made to change a condition so damaging to the profession and to the public. This inappreciation of one department by the other is not unnatural—neither side has taken sufficient pains to observe what the other side has done. The mere scientist instinctively believes that the achievements of the profession are so far due to the deductions of scientists that all other causes fade into insignificance; and the practician knows that just as far as animal life is from the disembodied spirit, so far is utilization of nature from the formulæ of heat, chemical affinity and mathematics itself.

The first step is to recognize the fact, and I beg engineers, especially those who from their scholastic habits, see least of the everyday embarrassments which are encountered by the executive departments of the profession, to take into account, not only the pride of class power, which the artisan feels as keenly as the scientist, but those baser elements of disunion, ranging from trades-unionism to counting-room dictation in technical affairs.

Having recognized the grave and comprehensive character of the evil, the next step should be, not I think, to attempt any violent alteration in the existing conduct of engineering by the men who are now in active service, but to change, if I may so say, the environment of the young men who are so soon to take our places, in order that their development may be larger, higher and in better balance. Two co-operative methods have been suggested—reversing the order of study, and organizing the practical school.

Whatever the course of improvement may be, it becomes us to leave some heritage of unity to the coming race. How shall we more fitly crown a century of engineering—a century in which our noble profession has risen from comparative potentiality to living energy? And as its force is multiplied by the general advance of science, it becomes the momentum which evermore shall actuate the enginery of civilization.

DISCUSSION ON PRESIDENT HOLLEY'S ADDRESS.

PROF. T. EGLESTON.—The subject of the President's address is one of very great importance to the profession. There is, as is evident to all, a want of concord between the schoolmen and the manufacturers, but the want is all on the part of the manufacturers. The President has shown us where the knot is, but has not cut it himself nor helped us to cut it. The unwillingness of some manufacturers to allow the student or professional man facilities, not for seeing the secrets of the trade, but the every-day manipulation, amounts sometimes to almost an obstruction to education. It is certain that this unwillingness arises in most cases, either from misapprehension of the object, or from want of tact on the part of the student. It may arise, also, from a well-grounded fear that the information asked for is to be used for direct competition, in which case it is well founded, and an act of self-protection. There are those, however, who are always willing to afford opportunity and facility for acquiring knowledge, to the student, and who do not acknowledge, either in word or deed, that any antagonism exists. To their kindness and consideration, many of us are greatly indebted for substantial aid in solving some of the difficult problems. Some generous-minded men carry the desire to aid further than is wise. We, of the schools, send students to the works to acquire knowledge which will be of use to them in solving problems given them to call both their knowledge and judgment into play, not to acquire *information* which is acquired to-day and forgotten to-morrow. Some of our friends furnish schedules, complete estimates, and lists of prices, in the most friendly manner, thinking to do a service. The result is, that the ease with which the information is acquired, leads the indolent, indifferent man to copy them verbatim, without any attempt at the very exercise of judgment, which is our principal object. The incipient engineer must decline to use such information, as his conditions are not the same; but the temptation to consider such a division of labor as legitimate, is, nevertheless, very strong. What was intended as a kindness is often no help to the investigating student, and a weight which helps to drag down the man who is willing to copy; such co-operation is not what is needed, and is no real kindness. When the School of Mines in New York was first started, it was stated, that for students who wished it,

application would be made for permission to work in mining and metallurgical establishments as the highest reward of engineering scholarship which the faculty could offer; but we were soon obliged to withdraw the promise, since the manufacturers would not grant the permission. Yet it is easily to be seen that out of such men, working for a given time without wages, the manufacturer might make, if he would, men of a high order of engineering ability. The difficulty is to make the manufacturer see that it is for his interest to have men trained to think and then to see. The day I graduated from college I left the machine shop in which I had been working, to take my diploma, and went back again to the shop, and after nearly a year's work went to a technical school. For the first year and a half that I was in the profession, though in charge of very large mines, not a single important question, involving mining, arose, but there were constant questions of pumps, engines, etc., and I was led at first to think little of my technical education until it became evident that the power to use the knowledge gained in the machine shop was the result of the technical training. It is plain to any one who gives the matter a moment's thought, that no amount of learning, which can be acquired in a technical school, can give the eye-education acquired by long practice in the works, and which makes every good workman an artist. A thorough education will, however, enable one to learn the nice distinctions, which are the basis of a correct judgment, in a comparatively short time. It seems to me very doubtful whether the ability to do the manual work is desirable in the engineer. The schoolman must have experience, just as the ordinary workman, but he acquires it in a much shorter time. Success in this, as in other things, is more or less the record of failures. As a general thing, the man who has never failed has never tried. The failures of the ordinary workman, looking over long periods of years before they become skilled, are not noticed or forgotten, but the failures of the schoolmen are more prominent, because so much, that is not fairly reasonable, is expected of them. It is evident that the young engineer must supplement his education at the school by training at the works, and if his failures in properly directed efforts are compared with those resulting from the efforts of men who have not studied abstract science, it is certain that they will be found the least expensive. What the President has laid out as a practical course means that men would not get into their profession until they were thirty years of age, which, in a certain point of view, is an advantage, but could not be carried into effect in this

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country, where men must begin to earn their own livings about the time they are twenty-one. What is needed is to increase the requirements and advance the age of admission to our technical schools, and then to overcome the antagonism of the manufacturers, and induce them to allow the graduates to continue their study with them until they could learn enough of the professional work they must do, to feel and hear, almost by instinct, as the President has so forcibly said, what they were to do. Such a system would soon train a class of engineers not to be had now. It is easy for the schools to give men the theory, but where are they to get the practice, if the manufacturer, miner, and metallurgist is to stand by them and say, yes, you ought to swim, you must swim, but we cannot by any means allow you to go into the water until you have learned how to swim.

Mr. Joseph D. Weeks.—I cannot agree with the last speaker, that there is always this want of concord, this disinclination on the part of manufacturers to allow scientific investigations to be made at their works, or if such a want or disinclination does exist, that it is entirely on the part of the manufacturers, or without reason. So far as my experience has gone, I have found the iron manufacturers of my own city, Pittsburgh, very ready to grant facilities for investigation, and work in perfect harmony with me in making experiments. At the works of Messrs. Rogers & Burchfield I spent many days experimenting on the use of natural gas in the puddling furnace, being at liberty to make any change in furnaces or their working I chose. At Messrs. Spang, Chalfant & Co., so far as I am aware, there has been every facility granted. But a week ago two gentlemen connected with the State Geological Survey were at these works making some very thorough experiments, and I know that a young gentleman, a graduate of the Professor's own school (the School of Mines), has been at these works for weeks.

Prof. R. W. Raymond thought the question of furnishing information to visiting students was chiefly one of courtesy and of present policy, while the question of giving a practical knowledge to students, or those who were to become such, was a much deeper one, bearing upon all the future. He thought that in many cases the questions asked of managers by students who called upon them were of a kind to embarrass one party without really benefiting the other. With regard to the suggestion of the President, that there are many considerations of practice which cannot be formulated, Mr. Raymond thought a large part of this imagined inability would disappear when greater culture was introduced among practitioners. A

mind trained to think and to express thought would deal promptly with many of the customs and rules of practice, discarding one-half as superstitions or survivals from necessities now obsolete—like the rudimentary organs of Darwinism—and classifying, explaining, and formulating the rest. The speaker did not believe much in rules or practices which could not be formulated. The trouble was the inability or disinclination of practitioners to state the facts. The President's recommendations would abate this evil. With regard to the combination of technical instruction with practice, perhaps the *Steigerschulen*, of Germany, are a good example. They have furnished some excellent mining engineers and metallurgists. He thought the introduction of a preliminary course of practical training before the scholastic training would be a great benefit to the schools themselves. It would weed out the hopelessly stupid, or lazy, or otherwise unfitted, and bring to the schools a class of young men who already knew what they wanted and really wanted it. The great difficulty with the schools to-day was to recommend themselves to the public—to parents. This could be done by the original investigations and publications of the professors, and still more by the practical achievements and business success of the graduates. Anything which tended to increase the chances of graduates to obtain opportunity of advancement, and to acquit themselves creditably therein, would benefit the schools. On the part of parents, the trouble is that they are in too great a hurry, and it is imperative that we should prove to them that a more thorough and prolonged training *pays*. Too many educators are at present engaged in the ridiculous attempt to adopt from the German system of university education everything *except the time it takes*. We keep on taking out a little more classics, and pushing in a little more science in our curricula of education, leaving the whole thing to be crammed in the same space as before. The speaker thought the only solution was to give more time, and most heartily agreed with the President that lack of general culture—of the knack of study, the power of statement, the sense of order and logic—was one of the greatest defects and drawbacks to the engineer. No illiterate man (using the term in a broader sense than that of inability to read and write) could become a distinguished engineer; or, at least, the most able engineer, if deficient in the culture which gives men power over their fellows, would be the first to recognize the lack, and lament the cause that had so crippled his usefulness and stopped him almost at the summit of that fame which could be completely climbed only by complete

men. One of the members of the Institute, a gentleman of high reputation as a manager of mines and works, had recently said to the speaker that he had concluded, after much observation, that a regular collegiate education was the best preparation for a technical one, and that the time so spent was well spent, and showed its benefit surely at the other end of the student's career.

Mr. E. C. Pechin.—All are agreed as to the desirability of closing the gap between theory and practice, and the future will, undoubtedly, develop the plan by which this can be accomplished; but the important present consideration is, if we cannot close the gap, may we not make it narrower. The plan suggested by President Holley is an admirable one all will admit, but its development will necessarily be slow because so radical. There ought, however, to be no real difficulty in the way of graduates of the schools becoming thoroughly versed in all matters of practice. There is an apparent obstacle, in the reluctance of the graduate to accept the prospect of a year or two of real hard work. I have had a number of applications from educated and competent young men, for positions, but in a majority of cases they wanted a good salary to begin with, and the nature of their duties must be rather genteel than otherwise. What they should say is, "I have had a thorough technical education, but I want a position for a year or two, where I can become thoroughly familiarized with practice. I only ask such compensation as will reasonably support me, and to labor for a given time in the various departments of your business."

There are very few masters who would not recognize the merit of such an application, and gladly assist so laudable a desire.

Several years ago, I accepted the services of a young gentleman, who had just finished a thorough course in the German schools. First acquainting himself with the nature of our materials, he then practically became a workingman. Whenever and wherever his services were required, he offered them, day or night, in the stock-house, or at the front. He carefully noted difficulties as they presented themselves in practice, and how they were met. The result was, that in one to two years he had mastered his business in both its aspects, and he is now, though still quite a young man, in my opinion, one of the foremost furnacemen in this country. Now, this would be my plan for making scientific practicians.

If our graduates would only cultivate that very un-American characteristic, *patience*—learn to labor and wait—their success would come sooner, and be more assured. The man who learns the art of

managing men, and to this adds a knowledge of chemistry and metallurgy, may become a giant, but with all possible learning, and wanting the ability to handle labor, which can only come by the knowledge of what is required of labor, he cannot hope for any large success.

This plan embraces another important point. Laboring men, as a class, are suspicious and unsympathetic, so far as their employer is concerned. By having associated with them, one becomes acquainted with their peculiarities, appreciates the difficulties they encounter, learns how to gain their good will, and this once gained, is enduring; and when the time comes for him to control, his power is well-nigh absolute, for he has learned when to watch, or relax, when to exact or indulge, when to be liberal or when unsparing. His knowledge obtained from books and in the schools, tell him what *ought* to be done; his practical experience shows him *how* it can be done, efficiently and economically.

PROF. R. H. THURSTON.—I listened to the opening address of our President last evening with very great interest, and should have liked to have taken an opportunity to indorse the general accuracy and practical promise of his views, and his plan of securing a more complete and thorough technical education and training last night, but that I presumed that an hour would be set apart, for the consideration of the more novel and more important of the propositions, which were then made. I have been asked to open the discussion this morning, and have gladly promised to do so.

I know of no subject which has more direct bearing upon the prosperity of the profession than this, and there is certainly not one which has a greater interest for me, personally.

As a mechanic and a practitioner, I recognize the correctness of much that has been said of the "schoolmen." As one who has been accused—but I am afraid unjustly—of being one of those schoolmen, I agree in what was said of the so-called "practical" men. Undoubtedly, both classes can do more to make our methods of technical education and subsequent training satisfactorily effective. Each must, however, help the other, and the best work will be done when they work earnestly, persistently, and patiently, hand in hand, with a common and well-understood aim, and by well-settled plans, each helping the other by every means that thought, observation, and experience can suggest.

The questions how, when, and where the requisite combination of theoretical and empirical knowledge of the principles of professional

practice, and the experience needed to make that knowledge most readily and fully available, are to be obtained by the aspirant, have been present in the minds of all thinking members of the profession, from the time of that great engineer, the Marquis of Worcester, who, two hundred years ago, proposed the establishment of technical schools.

It has appeared to me that we may pursue either of three distinct courses, in the attempt to effect this generally admitted essential combination. I say generally admitted, because there are members of acknowledged high standing in the profession, who assert that, however desirable in itself the education of the schools may be, no man can afford to give the necessary time to its acquisition. I am told by a friend, for whose views I have great respect—a gentleman who is justly distinguished as an engineer—that no man can attain full success in business, who has not gone into the business at so early a period in his life, that it is physically impossible to preface entrance upon his life-work by more than the rudiments of a common-school education. He insisted that only the man who began his actual practice of the profession, at an age at which his powers of observation and his ability to acquire by memorizing and by tactual experience are most fully available, can succeed.

While acknowledging that these views have much truth underlying them, I presume that very few would agree to the final deduction made from them. We may find a great difference of opinion, as to how much time the young man can spare to the pursuit of scientific professional knowledge, but we shall rarely find an advocate of its complete abnegation. The question to be discussed here is certainly not whether the young engineer shall have a technical training, but whether he shall secure it in one way or another of several proposed methods. We are not asked whether he shall have such an education and training, but how shall we give it, and when should he seek it, and where.

I have said that I would specify three courses, either of which may, perhaps, accomplish the desired result. These are:

First. That method which is most usually adopted, in which the student is given his education, and is then sent into business.

Secondly. That which gives the boy a common-school education, then sends him into the office, or the field, or the workshop, to acquire a certain amount of practical experience, business knowledge, and general development, and finally places him in the technical school, to obtain the professional education and scientific basis for a

sound reputation, which can there be best and most readily given him.

Thirdly. The course which, although usually most difficult to pursue, is, if I may judge from observation and experience with a considerable number of instances, the most perfectly and economically successful. That is, a mixed course of study and practice, extending throughout the early life of the man up to his final and complete immersion in the practice of his profession.

It is possible that I may be influenced by that prejudice, which most men have in favor of a course which has answered its purpose more or less fully in their own cases, or in cases which have appeared to them illustrations of great or of even moderate success; but I believe that the boy who, with natural predisposition toward a certain branch of engineering, spends his weekly holidays and his vacations playing about the workshop, growing up in contact with the workmen, and witnessing continually all those operations which, as he becomes old enough, he learns to conduct himself, imbibing, with that wonderful accuracy and rapidity for which boys are remarkable, all the traditions and recognized principles of shop practice, learning the construction and use of tools, and now and then acquiring the art of manipulating a machine or handling a tool, I believe that this boy will most easily and perfectly secure the technics of his profession.*

The course adopted generally in this and in all countries is the first of those specified. The boy is sent to school, and is given the usual common-school education. Upon concluding this course of study, he is sent to the college, or the technical school, and a four years' course of higher education having been completed, he is sent into business at the age of twenty or thereabouts.

He has then been engaged in the work of the student all his life; habits of study have been formed, and usually he has become, to a certain extent, unfitted for the vastly different kind of occupation which is now to be taken up. He has acquired habits of study, a good memory, and the ability to utilize it thoroughly, and has learned to make logically correct deductions from properly grouped facts. He lacks usually, however, the power of quickly perceiving and promptly acting upon such perception. He probably lacks decision, has lost some of that strength of character which may have been his by inheritance, and he has none of that experience which

* See note on page 40.

is essential as character and knowledge to success in business. He may possess a great store of learning, both general and professional, a well-trained mind, a sound judgment, and all that scholastic habits and training can give him, but he lacks the no less essential knowledge of men and of things which he can only obtain by a personal contact. He cannot manage his employés without either making unreasonable demands upon them or yielding to them more than is just. He knows nothing of methods of conducting business, and cannot have become accustomed to the hard rubs which so seriously disturb the tyro, and which so often discourage him at the outset.

Habits acquired in youth are always difficult to modify in later years. His habits are those of the student, and he must inevitably find it a seriously difficult matter to acquire the peculiar and distinctive habits of the business man. Once succeeding, however, he will rarely fail of full success.

The exceptional course in this country, and I presume in Europe, is the second of those outlined. The boy goes to the shop, or the office, immediately after completing his grammar or high school course, and learns the trade which leads most directly toward the profession which he proposes to enter; or, under the tuition of some practitioner, he acquires a knowledge of the ordinary routine of work and some idea of the character of the greater problem which he may expect to be confronted with in later years.

Arriving at the age of twenty, he sees the advantage of the possession of a knowledge of the science of his profession, and he leaves his practice for a time and devotes himself to study in some technical school.

His difficulty now is to acquire habits of study and the student's power of making his own that knowledge which he finds in books, and of grasping experimental data and of collating essential facts and grouping them systematically, and of deducing from them general laws of precise definition, and of well-determined range of application. He has to reacquire the mathematician's power of basing upon a statement of accurately defined conditions generalizations which find practical application in every department of human knowledge. He has to regain that fondness for research and study of which his business life has done so much to deprive him.

On the other hand, he has learned by experience to prize knowledge, both for its own sake and for what it will enable him to accomplish. He has learned in what direction he is to expect most aid from literary attainments and scientific knowledge. He can, to

a certain extent, distinguish between those branches of study which give only a mental gymnastic training and those which enable him to accomplish two objects simultaneously,—to acquire a store of valuable knowledge and, at the same time, to profit by a no less useful mental fulness of stature; becoming more of a sage and more of a man at the same time.

On the whole, I suspect that the advantages of this method more than counterbalance the disadvantages, and I have no doubt that, could this course be generally adopted, it would be seen to have an importance in the acceleration of professional progress which we probably hardly realize to-day.

Two great obstacles intervene to prevent the general adoption of this plan. The first is that conservatism which always retards the introduction of anything new, and which usually makes it necessary to agitate for at least a generation before a really great change can be brought about. Even when all are agreed on the question of the propriety of a step such as this, it is usually a long time before the public inertia is fully overcome. This is well illustrated by the fact that the necessity of technical education itself—proposed two centuries ago, and fairly inaugurated a century ago by Vaucanson, the father of the great *Conservatoire des Arts et Metiers* at Paris—is only just now beginning to be universally acknowledged by even those who are not hampered by a traditional proclivity in favor of the old Greek non-utilitarian idea of a purely gymnastic system of education.

The second great obstacle is the natural, and almost universally observed, reluctance of the young man, who has once become fairly inducted into business, and who sees opportunities opening to him in the immediate future, to give up all and to return to the school to secure advantages which his reason tells him are still more important, but which he, nevertheless, cannot fully realize, looking upon them as he does from a standpoint which does not permit him to see them as distinctly as he may in after life, when experience has confirmed the previous judgment. An active, energetic, and ambitious young man can rarely bring himself to the point of going back to the school after having once tasted the pleasures of success in business. Where this has been done, however, it has been almost invariably the fact, if I may judge from my own observation of quite a number of cases, the result is a most encouraging one. Could this plan be generally adopted, it would not only be decidedly better

for the young man himself, but it would prove vastly better for the schools.

The greatest difficulty met with in carrying out a satisfactory course of technical instruction in the schools, is that of finding students who have sufficient ripeness of intellect and of judgment, and sufficient physical strength to comprehend readily, grasp fully, and retain perfectly, the principles which are presented to them. Boys are sent to technical schools without well-developed habits of study, with insufficient and superficial preparation, with minds unripe and with bodies still taxing their systems by the drain of that vital power needed in carrying on the operations of physical development. Were the last-considered plan adopted, they would come to this work, which demands all the powers of maturity, with body and mind fully developed, and with an understanding of the extent, difficulty, and importance of the work to be done which would insure vastly better performance, and the accomplishment of vastly more in the time assigned to the course. The work of the instructor would be rendered more easy and more satisfactory to both himself and his pupil. The time would be far better utilized, and the greatest good would be accomplished in the given time and by the expenditure of the given amount of time and funds.

It is in this direction, I am pleased to find, that our President is looking for higher efficiency in technical training. If the plan which he proposes, of making our larger manufacturing establishments advanced technical schools can be carried out, it will prove, I am sure, a long step in the right direction. The final portion of the work of education would be done at a time when the student has attained sufficient maturity to appreciate it, and in the midst of such influences as will most effectually impress its value upon him. I sincerely hope that a way may be found of initiating this method of tuition, and that we may soon learn just what we are to expect from it. Difficulties will undoubtedly arise, but with the exercise of care in the choice, from among the many of the few who are adapted by nature and inclination to the pursuit of the profession, and with tact on the part of the instructor and a hearty good will on the side of the manager of the works, both, hand in hand, working for the accomplishment of an object the importance of which both appreciate, there can arise no insurmountable obstacle to final and complete success. When the schoolmen and the business men of the country put their heads together in the earnest desire to ac-

complish such an object, their united efforts will vanquish apparent impossibilities. I think that I can see this good time coming.

MR. E. B. COXE.—I, to a certain extent, had a practical education before going to the technical schools of Paris and Freiberg. During a portion of my youth I lived in the Lehigh coalfield of Pennsylvania, and having a liking for such things, spent a great deal of time in the mines, machine shops, foundries, etc., of that region, and made and assisted in making surveys both above and below ground. I found this practical education of immense importance to me in my technical education, enabling me to understand the details of mining, etc., when listening to lectures by the professors and studying the subject in books. There is another point to which I would refer. The mechanics we have at present are often men who do not serve regular apprenticeships, or if they do, work only at one or two nearly perfect machines; the amount of skilled labor in the large shops is being reduced to a minimum; one man works almost all his life at one machine instead of at all sorts of jobs. A carpenter, to-day, gets almost all his work from the mills, and is more of a fitter or joiner than a carpenter, and few carpenters work more than a year or two as an apprentice. Years ago a carpenter or machinist had to learn his trade thoroughly, and hence he was more familiar with the details of his business, and would not require foremen of such ability as at present. A mechanical engineer should therefore be acquainted with details of work, so as to be able to utilize these imperfect mechanics. A machinist must now go to a country shop, where the machinery is imperfect, in order to become a thorough workman in all the branches of his trade. I feel it would have been of great assistance to me in my education if, before going into the technical schools, I had worked practically in a machine shop and foundry for a year or two.

In the paper under discussion, there is one point which seems to me to be worthy of more consideration, that is, what Darwin terms the survival of the fittest. We always hear of the one man who, from a common miner, becomes a coal operator, but of the 150,000 other miners who do not we never hear anything. One thing that cannot be learned in the school, and which an engineer should know, is how to deal with men, how to make them work in accordance with his ideas. You may make a perfect plan, and have a complete drawing, but if you cannot impress your master carpenter, machinist or blacksmith with the idea that you understand it, and that

it is a good thing, it will probably not work. They will get a bolt or something else wrong somewhere.

Another trouble is the difficulty of graduates in understanding that they are not civil engineers or mining engineers, but only fitted to study the practice of those professions. The word engineer has become mixed in its meaning. I had, some years ago, a cart driver. After awhile I employed him to look after a small stationary engine. Now he is an engineer. I knew a slate-picker boy some years ago. After awhile he went with an engineer corps to carry stakes. He then became a chain man, then backsight man, and he got to use the transit instrument. Now he is an engineer. If business should grow slack, they go back to driving carts and picking slate, so that many people imagine an engineer to be a person who drives a cart, runs a transit, picks slate, or tends a stationary engine according as trade is good or not, and the popular idea of what is the proper pay of an engineer is too often based upon such conceptions of what an engineer is. Graduates should at first be satisfied if they can make their board. They will generally make mistakes enough to cover what they think their wages should be.

Mr. Oswald J. Heinrich.—I have listened with great pleasure to the remarks made by Prof. Thurston, and I am extremely glad to perceive that he fully recognizes the principles indispensable for a thoroughly practical and theoretical education of young men desirous of adopting any of the technical professions for their future careers. I rise as a strong advocate of his last proposed course, which is, according to my judgment, based on a long experience in many different positions, the only thorough plan for ultimate success. The questions involved in this controversy are of such importance, that one interested in this subject as much as I have been, for more than thirty years, may be tempted to talk beyond the limited time which can be devoted to this subject now. Permit me, however, to make a few remarks, taken mostly from my own experience during business life, which has been based upon the courses pursued in my native country.

There cannot be the least doubt, that at no time in the past has a partial education and training been sufficient for a man to fill, creditably, any position of importance in the various callings of the technical profession, and we need not expect that it will be different in the future. While partial experience alone, after perhaps a lifetime spent in a particular calling, may fit a man for a specific purpose, facts are not wanting to show that even such a man may commit

great errors, or even blunders, in disregarding well-known principles which would be thoroughly understood by one of far less practical experience, but possessing a school education. It is true, a really good practical man, with indomitable energy, may succeed ultimately, but probably only after dearly-bought experience, which otherwise could have been avoided, and wasted time and money saved. This being the era when the state of cultivation of a nation is measured, to a great extent, by the most thorough use made of waste material, we may just as well say, also, that this should be extended to the imponderable items of time and brain. On the other hand, a young man of a thorough theoretical education may deliver a lecture before a set of practical men which would fill them with admiration and awe, and yet he might be puzzled by the same set of men if called on to show how to do some simple practical operation. But the result may be, that other practical men may exult over the apparent superiority of the "indomitable" spirit of the practical man (probably themselves too ignorant to judge of the cost of his experience), and sneer at the failure of the scholar, and thus bring discredit on the attempts at liberal education of mankind. A long life in various practical callings may fit a man to fill even eminent positions, and, by being cautious, he may avoid such losses as have been enumerated, while, on the contrary, the unpractical scholar, possessed, as it is frequently the case, of too much self-reliance and mere book experience, may waste time and money to overcome practical difficulties. It is therefore not surprising to see the scale often over-weighted on the practical side.

It follows naturally, particularly in this country, that preference is given to the practical man. Unfortunately, for want of thorough understanding of the subject, the choice often falls upon a so-called practical man, and educational training has fallen into disrepute. The great drawback to obtaining a thorough, practical, and theoretical education in this country, will probably be less found in the means offered, than in the unwillingness to spend the time and money necessary to obtain it.

The order of the day in this country, "to make money," and, to a great extent, judging the capacity of a man according to the amount of money he has, or is earning, will unquestionably be a great drawback yet awhile. On the other hand, it is also impossible to obtain sufficient knowledge and experience during a few years of training, and in one particular course of instruction.

Taking my own experience, I had the good luck, from my early

boyhood until I had arrived beyond the years of maturity, to be alternately occupied in practical pursuits, and in receiving educational training, at schools of various grades. Until I had arrived at the age of twenty-three years I had never earned money worth speaking of, but spent my time from my fifteenth year in apprenticeships and going to various technical schools and public works. In my country, boys intending to devote themselves to technical occupations generally pursue the following plan, partially even regulated by law. After passing through the higher grades of the common school (*höhere Bürgerschule* or *realschule*) up to fifteen or sixteen years of age, where even, to some extent, Latin and Greek, but particularly modern languages, and the elements of mathematics and natural sciences form a part of the system of instruction, they are regularly apprenticed to the particular branch of business they intend to take up afterwards. As apprentices, they pass their regular time as carpenters, masons, pattern-makers, moulders, machinists at mines or furnaces, etc. Generally night schools, or schools during part of the winter (*handwerkerschulen*)—industrial schools—are visited during their time of apprenticeship, the time so spent being allowed as regular apprenticeship. They receive little or no pay during this time, according to choice and circumstances. After spending several years in this way, they enter the higher grades of the technical schools or colleges, to pass through a thorough course of scientific training, at the same time, in various ways, being constantly reminded of the practical duties necessary to be performed by them hereafter, by making excursions during the period of lectures, and during vacation visiting the public works and shops of the country. After graduating at these schools, they enter again for a time as volunteers at the different public works or private establishments, and are glad to be taken as such, without receiving any compensation, sometimes even paying for the privilege. After such a course, and proper examinations, they are only considered, even at private works, to be fit to take a subordinate position, and are often only too glad to get it.

I consider a good general education more than desirable before entering practical life for various reasons. The principal reason is, that the mind of the boy is more susceptible to mental training and exercise. During his apprenticeship, or attention to practical work, he will find out the great help he may derive from educational training. This is kept up by attending the night or industrial schools during that time. These preliminary studies, connected with prac-

tical exercise, will balance mind and body, both essential for a young man in those years of life. He will be by far a more attentive scholar at the higher grade schools, at least so far as my experience has gone, and will profit more by attending such schools than generally is the case with those who have first passed through the entire collegiate or classical course of studies. I consider this a very natural consequence of the necessary course of studies in industrial schools, they being better designed to prepare for subsequent training than the old faculty studies of law, medicine, theology, etc.

I can only say this much from my own experience, if I had not been trained and educated in such a manner as described above, it would have been impossible for me to fight misfortunes and ignorance which are necessarily encountered everywhere,—in a foreign country particularly—such as it existed in former years even in this country, and to a great extent even now.

A man who has charge of a work may be as wise as Solomon, but if he cannot show that he can lay the hand on the wheel himself, his subordinates will not confide in him. And this is particularly necessary in times of danger and difficulties, which may arise at any work. Association during his early days with the different classes of workmen, will make him more familiar with their notions, customs, and even their tricks, besides giving him at least some mechanical ability. Even if his constitution is not sufficiently strong to do a full day's work of a laborer, he may be fully able to say when a man has performed a full and good day's labor.

It is easy enough for men to manage a business where they are surrounded by good, able, and skilful men, or can get them at a moment's notice, as is generally the case in the old country, but it is absolutely necessary, in a partially settled country like this, for a man in such a position, to be in every respect capable of not only ordering a thing to be done, but also, if need be, to be able to roll up his shirt-sleeves, and show how it should be done. Men educated in such a manner may even aid the working classes, who cannot devote their time to hard study, by giving them useful instruction during their daily vacations as well as during evening lectures, and I have had opportunity to test this matter to my great satisfaction, finding our mechanics here willing enough to receive instruction when opportunity is offered.

I will, in conclusion, only say to our young men, study hard, and as long as you can, but be also not afraid, if you can improve yourself by it, to soil your fingers or your coat, even if it is at a

more moderate compensation than that of a first class superintendent.

NOTE BY PROFESSOR THURSTON.—The course of instruction in which workshop and laboratory practice is given simultaneously with tuition, in the several branches of study considered essential to the proper preparation of the student for professional work is becoming well recognized in this country as the most promising of good results, and a few institutions are endeavoring to give their students such a curriculum. A number of new technical schools are about to be organized, also, in which the same course will be attempted. Yale, Cornell, and Columbia, and the colleges at Bethlehem and Easton, and others, are pursuing such methods to some extent. The Rensselaer Polytechnic Institute at Troy set a good example of truly practical technical education many years ago, and the Massachusetts Institute of Technology is working in some departments on a similar plan. The Stevens Institute of Technology has been instituted, in deference to the character and wishes of the great engineer who founded and endowed it, as a School of Mechanical Engineering.

In the Department of Mechanical Engineering of that school, over which I have the honor to preside, I have endeavored to make the combination of theoretical, empirical, and practical instruction, to which I have referred as the third possible course, as complete as it could well be done within the walls of the college, and have complemented this tuition by as much instruction among the workshops and other establishments in the neighborhood of New York as opportunity can be found for. It would be premature to report definitely upon the result of this plan to-day. Several years must elapse before the real value of a method which aspires to make young men capable of going from the college into business and soon becoming efficient aids to older practitioners can be fully judged. I can only say that I originally allowed myself five years to determine whether it would be for my own interest to continue in a work which then seemed to me one of the noblest enterprises in which a member of the profession could engage, and that period having nearly expired, I am not inclined to feel less faith than I had at first in its success, and have not lost any of the enthusiasm with which I took upon myself that task. With less kindly, persistent, and cheerful support and example than I find in the presence of my colleagues and of all the officers of the institution, I may have had a different feeling;

but where all are working together in such a cause, discouragement should be impossible.

The student at the Stevens Institute of Technology enters after very much such an examination as is prescribed in all colleges of standing, and studies four years, at the end of which time he receives a diploma, which is to be taken as evidence that he has pursued with credit a course of study which is intended to be a suitable preparation for the commencement of actual work, and for beginning to learn the business of construction. He is called a mechanical engineer, which is to be interpreted as meaning that he is considered to be well fitted to *become* a good engineer. The first two years of his course are preparative, and during that time he is acquiring a good knowledge of the ordinary college courses in literature, mathematics, and the physical sciences, somewhat amplified and modified in directions which tend toward future practical applications. The next two years are devoted principally to professional studies, and to the application, in the laboratories and shops, of the scientific knowledge previously acquired. The student works in the chemical laboratory, on analyses of ores, metals, and the materials which he expects to make use of in his future life. He spends a considerable amount of time in the physical laboratory, making experiments upon whatever has a bearing upon his professional work, and learning the methods and the use of apparatus which are needed in all work of precise measurement, and he there becomes thoroughly and intimately familiar with all that the college student usually only knows by hearsay and by eyesight in the auditorium. Here his hands become expert in manipulation, and he feels and realizes all that we, who were less fortunate in our college days, barely comprehended, and never fully appreciated.

It is only here, and by these means, and with such actual tactual practice, that the student can be taught habits of accuracy, and an understanding of the difficulty which attends the acquisition of valuable experimental data. His mental training here is by no means the least important part of the work. In mathematics he pursues the higher branches, and devotes much time to applications throughout these two years. His instruction in the drawing-room extends throughout the full course. The earlier portion of this time makes him familiar with the use of instruments, and he gives much time to the graphics of descriptive geometry, and the studies to which that forms the introductory. During the final portion of his course in that department, if he has any inventive power or ability to de-

sign, he makes original designs of machinery and apparatus. The machines for testing metals, and for testing lubricants made in the mechanical laboratory, were designed more or less entirely by students.

In the department of engineering he devotes two years to the study of mechanical science, and to obtaining a knowledge of his materials of construction. He studies the construction of typical machines, and the form, as well as the theory, of the prime movers. He goes into the workshop two days in the week, and there learns the construction, the use, and the manipulation of machine tools. He acquires a little of the mechanic's "knack;" if he has a natural sleight, he gets a good deal of it. He there sees work going on in the hands of more experienced mechanics, and gradually acquires that kind of familiarity with such matters which is so essential to his future success. He goes into the little foundry and sees the moulder at work, and soon knows the technic of that business. More or less work in pattern-making, and the other subsidiary trades is usually going on, and he picks up enough in the shop, and from the lectures on the trades, to be able to advance rapidly when he finally goes out into real work.

The mechanical laboratory, which has been founded during the past year, is doing a considerable amount of work for private individuals, railroads, and other large corporations, and has done much experimental work for the neighboring municipal, State, and United States governments. This has been of immense value in giving the students an opportunity to witness, and frequently to take part in, experimental determinations of important facts and data.

They use daily the apparatus of the engineer in the lecture-room, and become familiar with the forms of the machines for determining the tensile, torsional, and transverse strength of materials, the steam-engine, indicator, etc., and occasionally have an opportunity to take part in the experimental work which is every day in progress. Students have taken part in tests of all kinds of materials of construction, of steam-engines and boilers, pumps, and other machinery, and have used the dynamometer, the pyrometer, and all the instruments used by the mechanical engineer in his professional work. They have taken part in some very important investigations and in some valuable original scientific researches. The exceptionally complete outfit of this mechanical laboratory, and the wide range of work obtained by it in doing its work, as a matter of business for all kinds of business men, gives opportunities which, confident as I was of its

ultimate success, did not, when I first attempted its organization, even imagine. It gives all these advantages, and, what is hardly less important, it pays its own expenses.

Viewing this experiment as a whole, from our present position, I can say that I see no reason to doubt that it is destined to prove itself as complete a success as its most enthusiastic friends have even hoped.

I have given this somewhat full account of the way in which this problem of technical education is taken up at the Stevens Institute of Technology, partly as an illustration of an actual and earnest attempt to carry out the method which I have referred to in my remarks, and partly for the purpose of giving those members who asked for more information a concise answer to their questions. I hope that I may have succeeded in interesting still more those who have exhibited a desire to see our methods of technical education perfected, and a high "modulus" of efficiency attained.

THE JOINT DISCUSSION

OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS AND THE AMERICAN INSTITUTE OF MINING ENGINEERS,

AT THE HALL OF THE FRANKLIN INSTITUTE, PHILADELPHIA, JUNE 19TH, 1876.

MR. A. L. HOLLEY, *Member of the American Society of Civil Engineers and of the American Institute of Mining Engineers,* called the meeting to order, and said:

GENTLEMEN: The members of the Joint Committee of the Civil Engineers and the Mining Engineers, to whom was given in charge the arrangement of this series of meetings, had proposed to nominate its Chairman as President of this meeting, Mr. Henry R. Worthington, who is, as you are aware, a thorough scholar in the principles of the profession, as well as a successful practician of wide reputation in various branches of engineering. As Mr. Worthington has been to-day most unfortunately prostrated by illness, I will nominate, confident of your approval, a member of the committee who is thoroughly conversant with its deliberations, and peculiarly competent to preside at this meeting, Dr. R. W. Raymond, of New York.

DR. R. W. RAYMOND, *Member of the American Institute of Mining Engineers,* upon unanimous election to the chair, said:

GENTLEMEN: The formal title of President, which Mr. Holley has conferred upon the position of Chairman of this meeting, has struck me with a little dismay, for it was my idea that this would be an informal conference rather than an organized, deliberative, and legislative assembly, but since there is to be a machinery, and a President, I think we cannot do better than go a little further. I would like to return the favor to Mr. Holley by nominating him as Secretary of the meetings.

(Mr. Holley was unanimously elected Secretary.)

Now, gentlemen, a word or two may be well in introducing the subject of the evening's discussion, particularly as many who are present to-night may not be so well informed concerning the antecedents of this discussion as are those of us members of the Institute of Mining Engineers who were present at Washington on the occasion which gave rise to it, namely, the address delivered by Mr. Holley, President of the Institute of Mining Engineers, at that meeting, on the subject of Technical Education. Portions of that address, and of the debate that followed it, have been sent to many of you by the Joint Committee. I have myself been requested by the Chairman of the Joint Committee to hold myself in readiness, in common with many other gentlemen who were expected to express their views on particular branches of the question, but the unexpected duty of opening the whole subject seems to call for a more general statement, of an introductory character. I cannot hope to make it altogether comprehensive, certainly not so comprehensive as I should have prepared to do had I anticipated that I should be called to this position, and not left to make my individual contribution merely to the drift of the discussion.

The question of technical education, as a whole, seems to me to have two principal bearings, the first being the technical education of the working-man, and the second, the training which should be given to those young men before, during, or after their school course, who pass through our technical schools in the hope of making for themselves a successful career in the profession of mining, mechanical, or civil engineering. And the problem presented by the first of these aspects, if once successfully solved, will perhaps throw a great deal of light on the solution of the second. I mean to say, if we could successfully solve the question of the ordinary education, preparation, and elevation of the working-man, in our industrial trades, we should thereby gain a great advance in regard to the education of the superintendents, managers, and overseers.

It has been found that a technical education, and special preparation of the working-man, in the trades represented by our profession, are absolutely necessary to him, to take the place of that system of apprenticeship which is now passing away, and to relieve the workingman from the restrictive influence of the new principles that have succeeded apprenticeships, and guilds, and caste, and paternal government, and official direction in every form. I speak particularly of our own land, where these old artificial restrictions have been removed, and we stand in danger of another class of tyrannies oper-

ating upon the working-men. One of these is the tyranny of the worst phase of trade-unionism, occasionally known among us, and another is the division of labor. Trade-unions are by no means an unmitigated evil, but all will admit that they may be carried to such extremes, and be so misdirected by ignorance or malice, as to become an overshadowing and stifling curse upon the community.

It has been observed by all those who have had to do with laborers in masses, that trade-unions cannot become thus powerful for harm, among men who are themselves so educated, and so emancipated, that they have individual and personal ambitions. In all *this form* of trade-unionism—and I am sorry I have no better name for it; I do not mean to stigmatize the whole system—we have a despotism, the shackles of which hang like a millstone upon the limbs of the working-man. Good and bad workmen are put upon one level. Attempts to earn by extra work, to save, to study, to compete, to rise, are discouraged or forbidden. Against such a dead weight, crushing labor to a uniformity of despair or sullen indifference, the only available and effective lifting force is the intelligent ambition of the individual laborer.

The great extension in modern times of the principle of the division of labor is another source of difficulty, demanding the same remedy. It is not an easy thing to deal with a division of labor, by which the workman is becoming a specialist, and narrowed down to the doing of one thing which he can do, and do well, and which he is made to do all his life, if he is willing to do it. He becomes almost a part of some particular tool or process, unless he is possessed of a fundamental education that will help him to turn his hand to other things. This evil is not yet, perhaps, so deeply felt among us as abroad. Our American mechanics and laborers have a certain readiness, superficial perhaps, but still qualifying them to do in tolerable fashion, upon short notice, many things, and turn from one thing to another. This readiness, as Mr. Coxe remarked on a former occasion, can be got, not in a large shop, but in a small one, where there are fewer workmen, and greater variety of work to be done. In large establishments, you know when a man gets to do one thing well, he is often obliged to stay at it. He is so skilful and valuable a workman in the spot where he stands, that it is to the interest of the employer to keep him there. But education, awakening and arming ambition, stimulating thought, and developing ingenuity, affords an antidote to this evil. Technical education of workmen may become necessary, then, to remove the restrictive

influences which I have named, and to give to them the *Open Sesame* so that they will have the possibility, if they have the ambition, to rise.

The effect of such training of workmen must be studied chiefly, I am sorry to say, in foreign countries, our own being in this respect lamentably deficient. I cannot pause, in the brief period allotted to me, to discuss this portion of the subject; but I beg to refer those Americans who take an interest in it, to a suggestive summary of foreign experience, contained in a little book on *Technical Education*, by Charles B. Stetson, published in 1874 by Osgood & Co., of Boston. That account is far from complete. It does not make mention, for example, of the *Steigerschulen* of Germany and Austria, for the instruction of working miners and metallurgists, which are among the oldest and most successful efforts in this direction. But, not to dwell upon these details, I wish to point out that such primary culture of the working-men renders possible the system of promotion from their ranks, without which they are driven to the worst style of trade-unionism in self-defence, but *with* which they are inspired at once by a laudable, honorable, and practicable ambition. These effects can be observed in the operations of the Cooper Union in New York—an institution which I need not pause to explain, still less to praise—almost alone in this country as a successful apparatus for the technical instruction of the laboring class. If the masses of our artisans, miners, and mechanics were possessed of such preparation in mathematics, drawing, and language as the Cooper Union schools bestow on their 1500 pupils, then there would be less difficulty in selecting from the bench, the lathe, the engine, the stope, and the furnace, men capable of rising to the intelligent control of great establishments.

But, it may be said, how will this help the case of those who, after years of study in colleges and scientific schools, find it impossible to gain entrance into practice? If even now, when nine workmen out of ten are mere drudges at a specialty, and incapable of promotion, our school graduates find it hard to get places, what *will* they do when workmen are educated? I reply, that they will be forced, probably, to begin as workmen, but that such an apprenticeship will be far less difficult than now, because it will be served among comrades who have learned the meaning and value of science, and who will gladly co-operate in the exchange of ideas and experience. This is not a mere Utopian dream. The fellowship of knowledge is a reality, and comes to pass whenever the vulgar scorn which the ignorant

feel for learning, and the vulgar scorn which the indolent feel for labor, have been swept away by the simple expedient of making the worker study and the student work. You might as well tell me that if I were hungry, but had plenty of water, and should meet a thirsty man with plenty of bread, we could not come to an understanding and an equitable exchange, as to tell me that theoretical and practical knowledge cannot complement each other under such circumstances.

But the present practical difficulty still remains, how to give to students, either before, during, or after their course of technical study, a knowledge of practice, such as will qualify them for positions at least of subordinate responsibility, and put them in the line of promotion. In the admirable address of President Holley at the Washington meeting of the Institute of Mining Engineers, a plan was suggested which merits not merely discussion but trial. It proposes a period of practical instruction in the shop or works, after the student has received a good degree of preliminary culture, but before he has begun his strictly technical studies. I shall say a few words on this plan as applicable to metallurgical industry, for it will not have escaped the attention of those who heard or who have since read Mr. Holley's address, that its suggestions more particularly concerned the mechanical engineer; and the question at once arises whether his plan is necessary, feasible, and advantageous to the metallurgist.

1. In the first place, it must be recognized that metallurgical processes involve more and more the arts of civil and mechanical engineering. They are carried on upon a larger scale than ever before, and hence they require heavy constructions and complicated machinery. For a great part, perhaps the greatest part, of the duties of the metallurgical manager, whatever is necessary to the training of a mechanical engineer is necessary to him.

2. It is more easily practicable for the student to gain a general acquaintance with many mechanical tools and processes in metallurgical works than in the machine shops themselves. For the repairs and alterations of machinery around such works give a variety of illustrations which the original construction in large establishments, where labor is rigidly divided, does not offer to the student or apprentice in any one department. But, on the other hand, the actual elementary knowledge is perhaps more difficult to obtain, because the operations at metallurgical works require, but do not train, skilled mechanics.

3. As to the manual part of construction—the masonry of furnaces, for instance—it can be readily learned at the works, where constructions are almost always in progress in some form or other. But I think that if the student has had beforehand sufficient training to understand the use of working drawings, and to be able to make such drawings, he will profit better by this practical experience.

4. As to the purely metallurgical portion of the work, the charging and operations of mills and furnaces, the sorting and testing of ores, the manipulation of products, etc., there is no doubt that a practical familiarity with the facts as they exist will facilitate the comprehension of theories and general rules. But the student cannot go far, and ought not to go far, without the aid of chemistry; and I am inclined to think that a general knowledge of that science, and some experience as an assayer, will prove most useful preliminaries.

5. Is it feasible to introduce young men into metallurgical works on the footing of favored employés, that is, employés who are not to be kept indefinitely at a single branch of the work, but who are to be passed from one department to another, until they shall have acquired familiarity with all, as a preparation for thorough study of the sciences underlying them? I think it is feasible in some kinds of works, and scarcely so in others. In gold and silver stamp-mills, for instance, the formal arrangement contemplated by Mr. Holley is not necessary. A young man of intelligence, activity, and trustworthy character, has only to make himself useful in any capacity, as laborer, bookkeeper, or assayer, around such an establishment, to gain the *entrée* to all its mysteries. And permit me to say here, that in small mining and metallurgical enterprises generally, I think the bookkeeper stands the best chance of promotion to the manager's place, when it becomes vacant, if he is ambitious, and makes good use of the opportunities to gain a knowledge of the whole business, which no other position offers in equal measure. This is of course not always the case. In very large establishments the bookkeeper may be closely confined by the mere clerical drudgery of his place.

In conclusion, I wish to emphasize what I remarked on a former occasion, that whether technical instruction be preceded or followed by manual practice, one thing must precede both, to insure the highest success in any profession, and that is general culture. For success is a social matter; it depends upon a man's influence over men. Knowledge of facts and laws in nature will not achieve it.

The most thorough metallurgist or engineer needs to be able to make other men recognize his ability. Nay, long before he can acquire thoroughness, he is dependent upon other men for every chance of practice. A liberal education gives power over men; and the technical education which gives power over matter will be twice as easily gained, and twice as effective when gained, if it is grounded upon the mental discipline and the moral strength of a culture wider than its own.

The more one observes the careers of men about him, and the more one wrestles with difficulties of one's own, the more profound becomes the conviction that a young man makes a great mistake, who, because he is going to take a technical education in engineering, deliberately decides that he will not have any general culture to begin on. I am not speaking of the men who, struggling against cruel necessity, make their way honorably and effectually, in spite of early disadvantages. Such often win a place among the greatest names. But the reason is very simple. It is just the same reason as makes the Indian a hardy son of the forest. Excessive exposure, hardship, insufficient food and clothing, do not make men hardy; they merely kill off the men who are not hardy, and those who survive must be the vigorous ones. Poverty, ignorance, isolation, difficulty, are not elements of strength; they are obstacles over which strength, and strength only, can triumph. Infinitely better they are than the luxury that drowns ambition and breeds swamp-gases of indolence and vice; but in themselves they are hindrances. A man who is truly a man will not be enervated, but enlarged and stimulated by liberal culture.

I would appeal to no one sooner than to our self-made men for a hearty recognition of the value of such preparation. They have felt the lack of it too keenly not to wish for their children a better chance. Now, with due caution against the waste of time, I cannot doubt that a general culture, though it may not be the quickest preparation, will lead to the best results. I remember the remark of a man of great success and quick observation, who assured me that if his son would become a metallurgical engineer, he would put him through college first, and let him begin his special studies afterwards. I am not prepared to say that an entire college course is necessary, or that it is the best preliminary course, though I have a high opinion of it, but something equivalent to it, or to a part of it, that is, what our German cousins give to their young men in the *Gymnasium*. They give to them a liberal culture in the beginning;

and it is a very remarkable thing, that amongst the many skilful metallurgists and mining engineers from Germany with whom I have had the pleasure of becoming acquainted, I have found a large proportion who had learned Greek and Latin, could perhaps even play on some musical instrument, and were widely acquainted with literature.

Finally, we must recognize the fact that individual character is, after all, the decisive element in success. We may devise plans without end to facilitate the manufacture of skilful engineers, but the men who have fidelity, honor, virtue, courage, and that genius which has been well defined as the power of application, will make their way surely to the top, either by the help of our arrangements, or in spite of them all; and of these born and bred leaders of the profession, those who have the broadest culture, other things being equal, will stand easily first.

I will now call upon Mr. Thomas C. Clarke, of the American Society of Civil Engineers.

MR. THOMAS C. CLARKE, *Member of the British Institution of Civil Engineers, member of the Society of Civil Engineers, and of the Institute of Mining Engineers.*

MR. CHAIRMAN: All will admit that education by books and education by practice are both necessary to a perfect system. The practical question that we have to discuss is, "What or how much shall be taught from books, and what or how much by practice?" Let us once satisfactorily answer this, and the rest is easy. The time to be occupied in each and the order of study is of minor importance.

Civil engineering is what is generally termed one of the practical sciences. A practical science is the application of scientific laws in various departments to serve practical ends which govern their selection and application.

Thus civil engineering being the art of scientific construction (of construction in accordance with the laws of nature, and not in ignorance of or against them), selects from the abstract sciences mathematics, and applies its branches of geometry and algebra to surveying and measuring. It selects from physics, chemistry, geology, mineralogy, etc., whatever is necessary for its purpose, and cares for nothing else. The pursuit of abstract science meets with its respect, but does not command its attention.

The study of the abstract sciences should be thoroughly pursued before we begin to practice, for that is the only time that we can

properly give to it. The application of these abstract sciences should be left until we come into practice, because men engaged in practice are best able to judge properly how that application should be made. Practice is constantly changing, and the applications of science have to be modified daily.

Moreover, the power of observation will not be thoroughly acquired until the student goes into active practice, while in the schools he deals with the symbols of things, and often does not recognize the thing itself when he sees it.

The schools should confine themselves to teaching principles only. That moment they attempt to teach the application of these principles to practice, and endeavor to teach their students how to design cars, engines, and other machines, permanent way, bridges, roofs, dams, and such pieces of construction, they either are ten to twenty years behind the age, or else they incur the ridicule of practical men by teaching how to make something of no use.

I have already expressed my views before the American Society of Civil Engineers as to the order of study that I would recommend. This, however, is of minor importance as compared with the previous question of *what* to study.

I would recommend that the engineering pupil get as sound a general education as possible, including the principles of the sciences. Let his early education be rather that of general culture, developing his mind, strengthening his powers of observation and judgment, teaching him to generalize. This course he should, if possible, pursue up to the age of eighteen or twenty. Before that age the mind and body are not generally sufficiently developed to endure the physical hardships of engineering. Then let him spend several years in practice in the machine shops, in the field, in the drafting-room, and in the office. Let him learn to deal with men and things, and to understand the conduct of affairs. Whether he will return to his books again depends upon what sort of a man he is.

I believe that all men, or nearly all men, from the natural constitution of their minds, fall into one of two classes.

They are either the men of executive ability, the practical men, *par excellence*, those who have a natural talent for affairs, the organization of labor, and the direction of men; or else they are the men of science, the investigators, the men who are hungry for knowledge, and will learn the reason why. Very rarely one man unites both qualifications. James Watt did, and so did Professor Morse, but such men are rare.

If the young engineer belongs to the executive class, having once plunged into practice, he will probably never go back to his books. But the other kind of man will do so, either by himself or in the schools. When he will have found out exactly what his deficiencies are, and he will be able to judge (much better in most cases than his professor can) what it is desirable for him to learn, you may be sure of one thing, he will study the principles of science, and pay very little attention to their application as taught in the schools. He will not spend his time over the pages of Rankine, learning how English permanent way was made twenty years ago, before Mr. Bessemer was heard of. Whatever he studies will be of value to him, and no one can judge of that better than he can.

One thought more and I have done. To all classes of engineering students let me point out the immense value of acquiring and fully understanding the *scientific method.*

This is, first, the art (for it does not come by nature) of observing facts and acquiring data; second, of observing the relations of phenomena and of drawing conclusions therefrom; third, of verifying those conclusions by observation and experiment.

Robert Stephenson, in alluding once to the vast progress of modern engineering, in which he himself had borne so distinguished a part, said: "We found it a craft, and we have left it a profession." That is to say, it had been put on a scientific basis, and by the use of the *scientific method.* This, after having been applied to the construction of railways, is now beginning to be applied to their management, and the results are remarkable, and promise to be more so.

To give an instance. The invention of the recording dynamometer, by Mr. Dudley, enables us to determine the resistance of trains at different rates of speed, and consequently of the number of foot pounds of energy required to move them, which is only another name for cost.

It was formerly the opinion of practical men that *ten* miles per hour was the most economical speed for freight trains. The instrumental observation shows that eighteen miles per hour is really the most economical speed. Perhaps ten miles was right in the days of iron rails, but now with steel rails and better rolling stock eighteen miles is the proper rate.

But how long would it have taken the man who was not possessed of the scientific method to find this out? And consider the value of the information thus obtained. It means postponing the cost of

constructing additional freight tracks, until the freight business has reached a point nearly double that which it was supposed would require them.

Other instances might be given of the value of the scientific method, but this is enough.

CAPTAIN DOUGLAS GALTON, F.R.S., *of London.*

MR. CHAIRMAN AND GENTLEMEN: I have so little knowledge of the American system of education for engineers, that I fear I may add very little to your information on this subject, except by perhaps giving a short account of the arrangements which have been made by our Indian government for the purpose of endeavoring to create a department of civil engineers for India. The Indian government has recently, that is to say, within the last three years, undertaken the construction and supervision of a much larger share of the public works than it had previously done. It decided to make new railways under its own officers; therefore it required the assistance of a large body of engineers. The first idea was to obtain the assistance from the civil engineers of England, and to induce young men of that class to go out and accept service under the Indian government as civil engineers; but the civil engineer is, as you are well aware, a very expensive creature, if he is trained sufficiently in practical skill to be of real value.

The government of India were not disposed to pay for the article the amount which was required to purchase it. After the failure of that experiment, in consequence of the inadequacy of the terms offered, the Indian government determined to create a school of their own, and they have established, at a place called Cooper's Hill, near London, a college of civil engineering. The pupils for this are selected by competitive examination, and they are then subjected to a course of technical education. This course is admirable as a theoretical course; the young men are taught, as far as possible, a certain amount of each branch of engineering. This is the theory, but the real difficulty lies in giving a practical education to young men in the schools or in colleges. You may teach them by models the art of bridge building, or the principles involved in the construction of revetement walls; or you may cause various sorts of work, as a plaything, to be executed by or under the eye of the student; but it is perfectly impossible that those difficulties of engineering which are of daily occurrence in actual works, and which are the things

that give the engineer his real practical knowledge and education, I say it is impossible that these can be taught in any schools. The young men, when they leave Cooper's Hill, proceed to India, and are placed under government engineers. It is almost too soon to say what the result of this will be, but I think it is not difficult to predict that it cannot have so favorable a result for the government as the result would have been if they would have been willing to pay for students who had been educated under our leading civil engineers, the price which would have attracted them, and it was not a very large price that would have attracted them.

There are two causes which militate strongly against the success of such a system.

First, the career of these young men depends upon their being regarded with a friendly eye by their superiors; that is to say, that promotion more or less depends on favoritism.

Secondly, government service is antagonistic to inventive genius; its leading principle is that the younger men should conform to the precedents established by their superiors. No encouragement is given to the development of new ideas.

Of all professions the civil engineer's is the one of which new ideas are the life's blood; it is, therefore, the one which should be least trammelled by being made a government department.

It is noteworthy that the colonial office, which has jurisdiction over certain of our colonies, and is independent of the Indian office, has recently generally selected the civil engineers for service in the colonies from the civil engineers of England, and this plan has proved very successful at no inordinate cost.

In some of these colonies where considerable works go on, as railways and roads, they have an organized service of civil engineers, which has been selected from pupils of the civil engineers in England, and their chief advisers in the selection have been our leading civil engineers. Moreover, the system at Cooper's Hill is very similar to that which had long prevailed in India, namely, that of employing the officers of the Indian engineers on public works. These officers used to have the same sort of theoretical education as the Cooper's Hill students—perhaps not quite such a high one—they had not the opportunity of getting that practical knowledge which is necessary to an engineer, and they therefore had to acquire the practical knowledge at the expense of the government, and many serious errors were made in construction from that cause.

It is a far more expensive thing to pay for the education of engi-

neers by means of their failures, than it is to purchase the educated, practical engineer, at the highest price in the market. I was not aware that the question to-night was to embrace so large a field as the President shadowed forth, or I should have taken more pains to give you further information on another branch of technical education, namely, that of the technical education of working-men, because in England we have a recent example of the efforts made to improve the technical education of the artisan, by that eminent scientific machinist, Sir Joseph Woodworth, who has put in trust a sum of two hundred thousand pounds for scholarships, to be given to the working-men who will distinguish themselves in a technical examination, and these scholarships are for the purpose of allowing a certain sum yearly to students for a limited number of years, to enable them to have an opportunity to improve themselves in their education.

I will briefly lay before you a few points as to the sort of education civil engineers receive in England. First they receive a liberal education at some school or college, and then the rule is that they go as regular or apprenticed pupils to a leading civil engineer for a specified time, and they pass from that state of pupilage into assistants, and finally they settle themselves on their own basis. Mechanical engineers invariably serve as pupils in the shops of some of our leading machinists, and they, as a rule, pass through all the mechanical processes in these shops in detail, as well as through the drawing office, and the model-room, as a part of the course.

Mr. Robert Stephenson once said to me that he considered that he owed a great part of his success in life to his father, old George Stephenson, having insisted upon his working in the model-room of the foundry for a whole year, or two years, before he would allow him to proceed to other classes of work. He said that gave him such a power of judging of the forms of things, that it was of immense benefit to him. I would only add, in conclusion, that however much education you may give a young man, you can at most only teach him how to learn. The real education is what he gives himself after he leaves his instructors. It will always depend upon the young man himself whether he makes an engineer or not.

MR. COLEMAN SELLERS, *Member of the American Society of Civil Engineers and President of the Franklin Institute.*

MR. PRESIDENT AND GENTLEMEN: Mr. Holley some time ago, inclosing a copy of a circular which I hold in my hand, asked if I

would speak on the subject of the Technical Education of Engineers, as such education relates to machine shops and foundries. In preparing mentally what I should say this evening, I naturally thought only in relation to the question here asked, "Shall a course of instruction in works precede, accompany, or follow that of the technical school?" but so much has been said to-night about the technical education of workmen, that I can hardly avoid saying a few words on that subject.

More than fifty years ago, a few earnest mechanics of the city of Philadelphia met together, and feeling that they needed some means of instruction not obtainable in the ordinary course of their lives, founded what they called the Franklin Institute of the State of Pennsylvania, and in time came to occupy the building in which we are now holding this meeting. Almost the first act of their existence was the foundation of a school for teaching drawing. For very many years there were no schools in Philadelphia to teach mechanical drawing, other than the one existing in this building.

From the Franklin Institute drawing school sprang the Women's School of Design, which has since grown in usefulness, but if at the present time you examine into the free school system of Philadelphia, and I imagine of some other cities, too, you will find that it is with the utmost difficulty that the teaching of drawing has been introduced. It has been declared by the authorities in some instances that there shall be drawing taught, but practicably there is none, even with such a rule existing. Now, Mr. President, I hold that the very foundation of all engineering practice is the knowledge of that language which is the universal language of the world, the language of the pencil, a language expressing in form what we desire to explain.

If this language of the pencil could be taught to all children, even if they did not get quite so much grammar and quite so much of some other branches in the schools, they would be better fitted to be workmen, and would make better workmen, too, but, unfortunately, everybody has not the same idea. The tendency of the school system of the city of Philadelphia tends directly towards making young men accountants or traders, or, it may be, giving them an idea that they are to be doctors, or lawyers; and not one word is taught them in the direction of the industrial arts. They do not have a chance to learn the meaning of the commonest terms of the machine shop or the foundry, or of any of the trades. Now the want of this system in the public schools underlies the whole trouble

of technical education in America. We do not in the common schools impress children with the desirability of earning their living by handicraft, nor do we train their minds to fit them to direct the hands of others in the industrial arts. Least of all do we give them any hint of what they want if they are to be engineers. Some technical education is needed to prepare them for a higher practical capacity on leaving the schools. The high schools now, it is true, teach many things that are very useful for them to learn, and too much cannot be said in praise of what is really the People's College of Philadelphia.

Now, in regard to the question of what shall be done with our sons, assuming that we would like them to be engineers, to follow in our footsteps. I am sure there is no father who listens to me now, who has not had this subject very seriously brought to his attention. For my part, I speak feelingly and from my heart, when I say that it is a question which cannot be always satisfactorily answered. I considered it gravely for a long time before I concluded what was the best thing to do with my own sons, and I may say what I have done with them is what I think is right for others to do with theirs under similar circumstances. I cannot but indorse Mr. Clarke's advice to secure for our boys in their education, as broad a foundation to stand upon as possible. I am sure this cannot be done by sending them to a public school only; they should have some college education; colleges properly organized will grow into favor as training schools for engineers. I am not sure that the ordinary university course of Latin and Greek is the best, but even this has its advantages, provided the young man can spare time enough before entering upon his life work to obtain some scientific training besides. I really think it would be a good thing for our young men to go through a thorough collegiate course, and then take something of a scientific course. But the end seems to be more nearly met by establishing in all our universities, scientific schools. Where such schools are founded, the student will enter college, and may work for two years with those who are studying a regular classical course. They will learn much that will be of great use to them in after life; they will master language so as to obtain the power of intelligent expression of their thoughts; they will understand the use of words better than those of us who have not had these early school advantages. The ability to tell other people precisely what they think, and what they want to impress upon them, is in itself a power. Their minds will be expanded, and in the course of two years, they probably may have found out what

they want to do in the future, though I do not think that any boy, and when I speak of a boy, I speak of one under the age of eighteen or nineteen, can possibly tell what will be the proper place for him to occupy in this world.

There is a place, I presume, for everybody, and each will after awhile drift into his proper place, and may become distinguished in that place if he can fill it properly. In illustration of this drifting into place, I would add, that if you will go upstairs, and look over the roll of members of the Franklin Institute, through its fifty years of existence, you will find names of members there, with their occupations opposite to their names as they wrote them at the time they signed. You will find one name there that I well remember, and opposite that name you will read the word "bricklayer." He is now a very celebrated architect. And so with the name of another member of the Franklin Institute, who is really a very able mechanical engineer, and quite a good constructive engineer. Had he signed his name to that constitution, when he was some years younger, you would have found opposite that name the word "shoemaker." Now, that man at that time, I have no doubt, was an excellent shoemaker, but he had in him the making of an excellent constructive mechanician. Since then he has found his proper place. If we could determine exactly what our boys are likely to be, what would be the best for them to do, then we could look over the course beforehand; but as we cannot do that, I think the position held by Mr. Clarke is exactly the one that should be pursued, and that is, to give them as broad an education as possible, but in giving them this education, I would like to have one idea pretty well emphasized, and that is, that a college will not teach them anything at all of practice, but that it will teach them what they want very much to know, and that is, how to study. They will surely learn methods, the methods of thought; they will by application study lessons, obtain a correct knowledge of the habits of thought, and methods of scientific investigation. Thus they will learn that they must never try two experiments at the same time, if they want to arrive at the bottom of any matter. They will realize the advantage of making one experiment at a time, and, eliminating all the errors, finally come down to the hard facts which they are seeking for. This is one thing they learn to do. Now it makes no difference if they cannot see how they are going to apply this when they come into the workshop. My word for it, they will see its value when they are once at work, and engaged in digging their own way through sometimes very rough experience.

Then it is they will turn back to the knowledge stored in their minds at college, and readily apply it to their work. But to reap the full advantage of all this, they must come out of college feeling that they are technically, perfectly ignorant; they must be willing to learn of practical men what constitutes the practice in machine making. If a young man can have a proper education in that way, and be induced afterwards to enter the shops and work his way up, beginning at the very bottom, and never shirking any work because it is dirty or disagreeable, you may depend upon it, the young man will grow up to make his mark in the world. These qualities obtained by education may be developed into administrative ability, and show their usefulness in making the boy a man capable of leading men. The trouble with most young men who have gone through their technical course is, that they feel they have spent a great deal of time in acquiring knowledge that should make them full-fledged mechanical engineers at once. They enter the shops, and feel sadly disappointed at meeting the young men who have no education, and are vastly their superiors in mechanical skill. This position, however, holds with them only for a very few months, because their habits of thought make them consider the reason why this or that thing is done, and when they have special training they rapidly go beyond those who have not had the same advantages. It is safe to say, that a young man, after passing through college properly, and having a good sound education, who determines to succeed in the workshops at any hazard, will in two years make himself so valuable in the position that he occupies, as to be elevated by his employer into something higher.

Now I say that I thought of this very deeply in the case of my own sons, and I did precisely, and I am doing precisely what I have just told you. I was not at all surprised, when I found my eldest son, after leaving the university, accepting a position in the workshop a little better than a common laborer. He commenced by chipping the scale out of the boiler. I tell you it was the best thing for him, because he made a beginning at the bottom, and did not shirk his work; it was as much as to say that he was willing to learn all that could be taught him in the shop, and he rapidly rose to a position higher than many who had been longer at work, but who had less book learning to back them.

It is impossible to make engineers out of pupils who have not engineering ability. There must be something in them that will compel them to take it up as a profession, and succeed in it. I am

now clearly of the opinion that as it is not in the power of most young men to take the college course, and then afterward to take the technical course; that it is far better for them to obtain what scientific knowledge they can in a good college, or in a technical college where something else is taught besides the exact sciences, where they can be taught the languages, not the dead languages but the modern languages, and taught at the same time rhetoric, composition, and all that will enable them to express themselves; and by all means let them have a good sound basis of mathematics before they venture their education in the workshops. Then when they have entered the workshops there will be time to acquire technical education without schools. I have no doubt that many who have been liberally educated, have, after entering the shop, felt the want of some technical education, and have broken away from the shop, and gone into schools to learn. They felt the need of obtaining more knowledge, and that the time they spent in the college or school was not sufficient.

I do not think it advisable as a rule, however, to take the boy from the workbench and send him to school a second time. I have in some instances noted the effect of such a course upon young men to be disadvantageous. If the boy has left school too soon, and feels afterwards the want of more knowledge, it is well enough, if he can, to return to his studies, but such return makes sometimes a disadvantageous break in his habits. I look upon it rather as a means of mending a defect in education rather than a course to be pursued as prearranged with an object. By not attempting to teach too much "practice" in the schools, time is left to give a good grounding in generalities, which cannot fail to be of use in any walk of life, and which can be better acquired when one is young. The practicing engineer has not only to master his profession, but he must learn how to place himself and his works before men so as to be seen of them and appreciated by them. He requires a very extended knowledge; all learning will at one time or another be of use to him; and habits of study, which will enable him to continue a student to the end of his days, will the more readily fit him to rise in his profession, and make him a leader among men.

THE CHAIRMAN.—What Mr. Sellers has so well said with regard to the ability of trained men, possessed of liberal education for mastering new problems or new branches in applied science, is very admirably illustrated in the case of a gentleman upon whom I

shall now call, a fellow-laborer of mine, and one of the old members of the Institute of Mining Engineers, who was once a very good lawyer, but who made up his mind, when necessity called upon him, that what anybody else could learn, a lawyer should be able to learn, and who took off his coat and went to work at his own blast-furnace, and became an excellent blast-furnace manager.

I call upon Mr. E. C. Pechin, of the Dunbar Iron Works.

MR. E. C. PECHIN, *Member of the Institute of Mining Engineers.*

MR. CHAIRMAN AND GENTLEMEN: In being called upon to speak at this point in the proceedings, I feel very much like a Lazarus sitting at Dives' gate.

After the admirable addresses of the chairman and of the gentlemen who followed him, so little remains to be said that I feel as if my part must consist in simply picking up the crumbs that have fallen from richer tables.

I can only discuss the question from one standpoint, that of a blast-furnace manager, as I am not sufficiently familiar with other branches to give an opinion of any particular value.

I cannot too heartily indorse the remarks of the gentleman who has immediately preceded me as to the vital importance of a liberal education as the groundwork of a professional career. *Modesty* is one of the most charming and valuable of human characteristics. As a young man lays broad and deep the groundwork of knowledge, as he enlarges the range of his acquirements, as he gathers information from varied sources, as his mind becomes widened, broadened, and liberalized, so does he feel his own insignificance, and how little he knows compared with the illimitable and exhaustless fields of the unknown lying before him.

The most unbearable of creatures is the youth who, thinking he knows everything, practically knows nothing; and if, by a liberal education, we can help to secure *modesty*, certainly a vast deal has been done, not only for the individual, but for those with whom he is to be brought in contact. With a liberal education as the groundwork, a subsequent technical education becomes an element of great power.

As far as regards blast-furnace management, the schools can effectively *precede* actual practice. A young man who looks forward to the position of manager of blast-furnaces of the present day cannot have too thorough a technical education, as his duties will be of the most varied character. Heretofore very many establishments

have been content to make iron out of purchased materials, but the tendency now is to concentrate the mining of ores and coal and the making of coke and iron all under one general management, greatly increasing the duties and responsibilities of the manager, and demanding of him a larger knowledge.

Though he may have efficient subordinates in various departments, he must be able to understand and check their work, and he will find it extremely useful to be something of a mason, bricklayer, and carpenter, largely a surveyor, engineer, and mechanic, and well up in the general principles of chemistry and metallurgy.

Hence it follows that the course in the technical schools cannot be too varied, and the best plan for an earnest student to pursue, while thoroughly mastering the particular branch selected as a specialty, is to get the groundwork of as many collateral branches as possible, as he will find in his after-life that nothing will pay him a larger dividend than varied knowledge.

After the schools, *practice*—not the practice that many of our scientific fledglings expect—a good salary and comfortable quarters, strictly business hours and social enjoyments—but earnest, hard, often disagreeable, and, it may be, poorly paid work, commencing at the bottom and going resolutely through, until all the details of his business are familiar to him. All the knowledge of chemistry and formulæ in the world won't help a furnaceman if his scales are out of order, if the furnace has slipped, or water is going into his crucible. The most perfect furnace and the best stock can come to grief if the materials are not properly filled at the tunnel-head.

I would start the graduate in the office, to become familiar with the method of keeping accounts. Many a hardworking iron-man has been insensibly ruined by faulty bookkeeping. Thence to the weighing department, to find out how to receive supplies and ship products. Defective scales or false weighing may knock the bottom out of an otherwise fair balance-sheet. Thence into the labor gang of the furnace, helping, filling, firing, keeping, until he is acquainted with every-day furnace life, the petty mishaps, and the more serious complications. From his fellow-workmen he can learn a vast deal that will be immensely useful in his after career. He will discover how many work intelligently, how many work honestly but ignorantly, and how many stupidly or wilfully shirk. At any rate he can find out the peculiarities of the average working-man, how distrustful and unreasonable at one time, and how generous and confiding at another. He ought to learn how to win the working-man

to his future support, and if he does this he will possess the power to snatch many a victory from the jaws of apparent defeat.

To sum up, first college, then the technical schools, then thorough practice, to make a good iron-master, provided always that the subject has the right stuff to start with. As Mr. Sellers's remarks have suggested, "You can't make a silk purse out of a sow's ear." If a youngster has shown himself a good student, practice will soon prove whether he will make a good manager. If the necessary qualifications are wanting, he will soon find his true level, but if they are present he will, by adopting the course suggested, rise surely and rapidly.

Quite apart from the financial and commercial results which will inevitably follow, his life will prove a success to *himself*. The habits of the student will cling to him through the busiest practical life; his desire for knowledge will never slacken; the scientific research of the world will become his property; and he can appreciate and practically apply what others have done and are doing; he can understandingly avoid the blunders, and intelligently appropriate the discoveries of his fellow-men, and possibly and probably will in turn benefit others by the results arising from the combination of a constantly ripening intellect and an ever enlarging practical experience.

Thus we shall have a thoroughly skilled mechanic, and at the same time, what is quite as important in my estimation, a broad-minded, intelligent gentleman, equally at home in his overalls among his men, or in his dress-suit in the society of the cultivated, refined, and intellectual.

COL. W. MILNOR ROBERTS, *Vice-President of the American Society of Civil Engineers.*

MR. CHAIRMAN: "The Joint Committee of the American Society of Civil Engineers and the American Institute of Mining Engineers on Technical Education" having requested me to join in the discussion, I cheerfully accede to the request, the discussion to be chiefly upon the following questions:

"I. Should a course of instruction in works precede, accompany, or follow that in the technical school?

"II. Is it practicable to organize practical schools, under the direction and discipline of experts, in engineering works?"

Being less familiar than many of my brother engineers with the details of modern technical teaching, my best excuse for entering at all upon such a discussion may be found in my acceptance of the proposition, that "in a multitude of counsellors there is wisdom."

I look back over my own experience, beginning many years ago, in the practice of engineering, when there was no such thing in this country as a technical school in any branch of engineering—in fact, before engineering could be considered established as a profession. There were engineering works here long before that, and, of course, engineers, but the time had not yet arrived when engineers were in sufficient numbers, or in sufficient demand, to support regular schools of technology. On this very site where we are now assembled, and in the old Carpenters' Hall, back of Chestnut Street, about fifty years ago, I was taught in a night school, architectural drawing (under the auspices of this same Franklin Institute) by the late John Haviland, an eminent architect of that day. This, combined with mathematical training (in the daytime) in the school of Joseph Roberts, then the best mathematician of Philadelphia, aided by his interesting weekly experiments in chemistry and philosophy, was the germ of the technical education of the time. It was prior to the era of railroads; hydraulic works, canals, etc., constituted the chief engineering employment of the few engineers then in the United States.

If I am not in error, this very society, the Franklin Institute (which has so kindly tendered us the use of its halls and library, and the most liberal personal attentions to both of our societies), was the first substantial practical movement in the direction of technical education, though beginning in a comparatively crude manner. Yet I am well satisfied that the lectures that I heard in the rooms of the Franklin Institute, which I always attended when I could, laid a good foundation, which no length of time could impair. The respected professors and teachers of that day have most of them long since finished their labors in this world, and may be laboring, for aught that we know, in another and more refined sphere of action. They have gone, but their works live after them. In weakness and inexperience they laid the foundation walls of the Franklin Institute, a little more than fifty years ago, and now nearly all its early members have departed, but the Institute has thriven and grown to man's estate, and it would be very difficult to estimate its real value as a factor in the technical education of the American engineering mind. Certainly it has been very great, partly in its preliminary training of youth, partly in its valuable practical lectures to young and old, partly through its numerous important scientific committees, and largely through its monthly publications, which permanently embody a large amount of technical knowledge, valuable not

only to the student, but to professional men of every grade of experience. I have, on the spur of the moment, interjected these reminiscences, in the hope that they will not be deemed entirely irrelevant to the subject in hand.

In regard to the training of young men of the present day for the profession of engineering, there are some preliminary considerations which it appears to me have not yet received quite as much attention as they seem to deserve, and they are becoming more important every day. It is but a few years since engineering in general took rank as a profession, and we look back to a yet shorter period when schools of any kind undertook to teach engineering as a specialty in any of its present branches, military, civil, mechanical, and mining; but modern progress has been so rapid, and operations demanding skilful engineering experience have so increased in number and magnitude, that already these several branches have become in themselves sciences, requiring for their proper development and treatment appropriate, distinct schools. All of these branches of engineering have assumed definite shape during the present century, and chiefly during the last fifty years. Not that there was no military, civil, mechanical, and mining engineering prior to this century, but that the business and wants of mankind had not yet advanced sufficiently to necessitate the formal organization of such professions. Since the introduction of the railroad and telegraph, with steam as the great motor for all kinds of machinery and transportation, an almost unnatural impetus has been given to all branches of engineering, and now we have schools and colleges specially devoted to the teaching of our youth, not merely in the preliminary or elemental parts, but in the more advanced and practical portions of these sciences, and annually there are now numbers of young men, who have passed through the prescribed course in their respective institutions with sufficient credit to entitle them to their diplomas, sent forth to take their chances for employment in some one or several of the branches of engineering.

Under such a comparatively indiscriminate system, two results follow, one, the spoiling of intellects which might be much more advantageously employed in some other business of life; the other, the general public loss from incompetent engineering service. It may be said that the professions of divinity, law, and medicine are exposed to similar mistakes and similar consequent unfortunate results. This is probably true, and perhaps the same general remedy may be applicable to all. It is certainly true that all the students

in any profession cannot arrive at the head. Some must be lower in the class than others, and some must be near or at the foot. Shakspeare says, "some men are born to greatness, and some achieve it;" it may be added now, "by diligent labor and untiring perseverance." Hence a course that may be appropriate and advisable for one student, may not be so for another.

Aptitude for a particular profession, and even for a particular branch of it, if it be engineering, has not yet been adequately studied or cared for by parents and guardians of children. The idiosyncrasy of every being is his own, and it is unchangeable, and it is possible, with proper care and judgment on the part of the parent or guardian, to learn its nature in their children or wards, before determining the particular plan of their education. There are undoubtedly legal, medical, theological, architectural, mechanical, and engineering minds, which, if properly trained in their natural channels, may become not only useful, but distinguished, and which, if directed and persistently held in the wrong channel, may prove to be abortions.

Regard being had to the aptitude of the individual, the particular course which may be advisable in his special case, should depend measurably, and perhaps considerably, upon the branch of engineering which seems to be best suited to his idiosyncrasy, whether military, civil, mechanical, mining, etc. While there may be a few instances of men whose minds and pursuits enable them to shine and to be more or less successful engineers in most of these branches, as a rule, those who attempt to figure in many will be likely to fail in some, if not in all. At the same time, an engineer in any department should of course be more or less familiar with the leading principles of all the cognate branches. Yet, with every year's augmenting experience in the world, the necessity for these separate branches will become more apparent, and a larger share of attention and time will be demanded in the individual pursuit of each. Science grows with the growth of the world.

It may be necessary, or at least advisable, when considering the subject of the proper method of training the young engineer, to have special reference to the particular branch of engineering he intends to follow. For any branch there must of course be a proper foundation, to the extent of a good English education (if German and French are added, it would be decidedly advantageous), and a ready use of figures, and of mathematical principles, to precede both technical engineering study, and practice—this in any branch.

In mining engineering particularly, the student to be reasonably accomplished, should also understand chemistry, as well as geology and mineralogy. In the other branches of engineering, chemistry may not be so necessary or important, although it is a kind of knowledge which is useful to all engineers. An accomplished civil engineer should be familiar with mechanical engineering, and not ignorant of mining engineering, though he need not, necessarily, be an expert therein; it could hardly be expected of him. His chief or highest duties are not embraced in either of those branches, and his principal requisite is ready, sound judgment, and the more this is strengthened and confirmed by experience, the better for his employers as well as for himself. Sound judgment can never be wholly the result of education, either technically in the schools, or in engineering practice, because it does not always accompany knowledge or even experience. For civil engineering, the teaching and training in those higher schools, where this department, with the use of instruments, is a regular course, the student can learn all that it is necessary for him to know, before taking a very subordinate position in a regular engineer corps in the field, where he would still have much, very much, to learn, which cannot be conveyed to him thoroughly in any other than this final school. One who would be a first-class mechanical engineer, as soon as he has the proper foundation of schooling already mentioned, should get at once among mechanics and mechanical practice, joining to his practice an intelligent study of principles, and gathering to himself the technicalities as he advances. Something, too, depends upon the special branch of mechanical engineering he may wish to follow. Mining engineering during the present century, and especially during the last forty or fifty years, has become a highly important branch of modern engineering, and only in technical *schools of mines*, or among mines, can it be thoroughly learned. The proper foundation referred to above is, of course, essential to the satisfactory advance of the student. In addition to this a taste for the profession, as well as the talent to enable him properly to exercise it, are indispensable to distinguished success.

I am less familiar with modern mining engineering as a science, than with any of the branches of engineering, and do not therefore feel competent to advise mining engineers as such, but from the drift of my remarks it will be observed that in a general way my experience would seem to favor first, the laying of a good foundation—a sound preliminary education, and secondly, going to work upon it as soon as possible thereafter, in the particular branch of

engineering the student intends to pursue. If that preliminary education could have the great advantage of such schooling as the President of the Mining Engineers, Mr. Holley, has indicated among *actual works*, it would surely be the very perfection of a foundation.

After all, however, those who would be engineers, or their parents or guardians for them, should have some reliable assurance that some kind of engineering, as a profession, is likely to be the best for the particular individual, and then, the kind of engineering should be determined upon and constantly kept in view during the preliminary or preparatory education.

I can speak freely in regard to civil engineering, from long experience, that in the United States at least, it has become of a very mixed nature, and that of those who have latterly entered into it, many have been sadly disappointed and very few quite satisfied. Many who without due consideration have rushed into the profession, would have done better for themselves in almost any other business or profession. Civil engineering has been largely overdone. Perhaps the same general remark may be more or less applicable to the other professions, although circumstances peculiarly favored a large accession to the ranks of civil engineers.

Since, however, the profession of engineering in its several branches may now be regarded as established, and as special professorships and special training in those branches respectively, in schools, must materially conduce to the permanent benefit of the pupils, and consequently of the profession, it would appear particularly in mining engineering, that a course of instruction in works should *accompany* that in the technical school. In mechanical engineering very much the same system would seem to be highly desirable.

In military engineering, in the national school at West Point, this is precisely what is done. Practice, so far as may be, goes hand in hand with technical teaching. In civil engineering it is practicable, only to a certain limited extent, when compared with the wider field which must at a later period be occupied.

It may not be equally practicable to organize "practical schools under the direction and discipline of experts in engineering works," in all of the branches of engineering, but in mining and metallurgical engineering it seems to me to be quite practicable and desirable, likewise in mechanical engineering. In civil engineering the real school is largely in the field, beginning with the rapid preliminary explorations of lines of canals, or railroads, or projections of waterworks, etc., extending through the processes of provisional and final

locations, up to the planning and construction of the various works and structures appropriate to the particular improvement. Those who by great experience become experts in civil engineering, are usually too closely occupied in the professional conduct of works to take an active or controlling part in the business of educating younger members, excepting as above indicated, by having them in their corps on active duty of some kind. The day may come in this country when civil engineering may assume a somewhat different shape, but at present it appears to me that the polytechnic schools in our country, in which civil engineering is a leading feature, furnish adequate training for young men desirous of becoming civil engineers. Of course the more thoroughly the teachers are themselves grounded in the practice as well as the principles of civil engineering, the better it is for the pupils, though it may be well to consider that the most expert, and the most experienced in practical engineering, are not necessarily the best teachers. There are men peculiarly well adapted to shine and succeed as teachers of young engineers, who would not be selected to take the responsible practical management in particular lines of civil engineering, while there are many instances of good practical engineers who would be likely to do no honor to a technical professorship.

MR. ASHBEL WELCH, *Member of the American Society of Civil Engineers.*

MR. CHAIRMAN: I suppose all agree that the future engineer should remain in the school or college till he is eighteen or twenty years old, and should get all the general education he can, up to that time, before he begins his professional education.

But experience shows that a *long* course of technical study, preceding and unaccompanied by professional practice, is highly inexpedient. I propose to glance at some reasons why it is so.

The object of the philosopher is to attain scientific results; the object of the engineer is to attain directly beneficial ends by using those results. One gets up the tools, the other works with them. Engineering education should therefore aim at readiness and skill in the application of science, rather than at scientific investigation or accumulation. The habit of mind good for one, is, when carried far, bad for the other. Too long study of science without applying it in practice, induces a habit of allowing knowledge to lie dormant in the mind, of regarding it as end, not as means, and to a greater or less extent, produces incapacity for applying it.

Many years ago, a foreigner was found on a work under my charge, plying the shovel and wheelbarrow, who had acquired a large amount of knowledge by years of study at a continental university. But though he knew so much, and was so expert in abstract science, he was unable to make any earthly use of it. He could not be taught to apply it to anything. In learning a giant, he was a child in everything else. This may be an extreme case, but it illustrates the tendency of all study and no practice.

On the other hand, practice keeps one on the *qui vive* to know the reasons for doing things, and the laws that operate. Old George Stephenson, for example, picked up a great amount of knowledge, because his practice made him hungry for it, and enabled him to assimilate it. Men of practice came to know, by what looks like intuition, things that science teaches other men only by a long course of reasoning. The habit of applying knowledge is more influential in inducing men to acquire it, than the possession of it is in inducing them to apply it.

A habit acquired in the practice of turning knowledge to account, is more valuable than a large amount of knowledge. In Franklin's time, myriads of men had much more knowledge than he had, but his habit of applying it made his little more valuable than their much.

Of course a man must have *some* science before he can apply it. But this he can get at school, or college, or in a *short* course at a technical school, while his mind is yet flexible. But a long course, reaching to a more mature period of life, fixes in the now rigid mind, a habit unfavorable to engineering success.

It can hardly be doubted that instruction in works should, when possible, accompany that in the technical school; just as the young lawyer or doctor learns to practice while studying.

Too much time spent on scientific abstractions and refinements (however useful such things may be to the philosopher), is more than wasted by the engineer; it unfits him for practical usefulness. Napoleon said La Place was good for nothing for business; he was always dealing with infinitesimal quantities.

A general ought to have been a captain in his younger days, but if a man continues to perform captain's duty up to the age of fifty, he is not likely to make much of a general. So an engineer should begin low down. But the student should not be kept long in acquiring mere manual skill. What he wants is mental skill. He should be

practically familiar with iron, but it would do him little good to be expert in making horseshoes.

It is only early practice that can teach the self-reliance, energy, and enterprise so essential to an engineer's success.

The engineer has to do with cases where the laws of nature act in different directions. Science alone cannot often give the exact resultant of those forces, sometimes unknown, often separately incapable of measurement. Experience must give the habit of estimating what allowances should be made for unknown actions and unknown quantities. Men of science once told the engineers to make fish-bellied rails, so that they should not break in the middle. The foundry laborers that broke up pig-iron could have told them that the rails would break close by the supports. Science teaches that with perfectly elastic bodies the angle of reflection is equal to the angle of incidence; practice teaches that with material bodies as they are, it never is. Time was, when for such reasons, there was some truth in the saying, that the stability of a structure was inversely as the science of the builder.

The best engineering is that which in the long run accomplishes the purpose at the least cost. The engineer should not be a mere engineer, looking only at engineering results, for then he will lose sight of their subordination to economic results. In this way so many parties have been ruined by splendid engineering. Actual practice, where money is scarce, is the best way to impress this on the young engineer. He should learn not to do, propose, or advocate anything that will not pay.

The engineering books in our schools often contain rules deduced from the experience of other countries that are wrong here. For instance, we were erroneously taught by English practice that fish-plates for rails should be only fourteen inches long, and that they should be of iron because steel would break. A young graduate once made a road for temporary use, and made the drains of cut stone, because his French text-book said that was the way to make them. It reminded me of what a man breaking stone once said: "For making roads I'd rather have one good broad-backed turnpiker than all the engineers this side———" (Sandy Hook). Early practice can alone prevent these errors from taking too deep root.

Leaving this part of the subject, I now propose to call attention to another and very important part of an engineer's education, using that word in its widest sense. I mean to inculcate as an essential feature of an engineer's character the strictest integrity.

One-eighth of all the wealth in the United States is railroad property. It is controlled by a few hundred men. Of these many are, or were, engineers. They were selected partly because their training fitted them for railroad management, and partly because they had a reputation for integrity. It is of the highest importance to shareholders and bondholders to find men perfectly trustworthy. No sane person will confide his property to a man of whose honesty he has not some assurance. Many a share would to-day bring ten or twenty per cent. more than it does, if it was certain that the management of the property it represents was, and would continue to be, perfectly honest. It is probable that character for integrity will soon be a much more influential element than heretofore in securing good positions and good salaries. The insurance the shareholder gets by the employment of a man of known integrity is worth many times his salary.

It is therefore, to say nothing of higher reasons, of the greatest importance to an engineer, to have a reputation for honesty. It is a very essential part of his capital.

But only a few individuals can be very widely known. Most men are therefore judged, not so much by what is known of them personally, as by the character of the class to which they belong.

Hence it is of the greatest importance that engineers, as a class, should have a character for stern integrity. One of the aims of these societies, and of the schools for the education of engineers, and of the individuals interested, should be to secure this character for those whom they recognize as engineers. To have the reputation they must have the thing itself; and they must keep out, and when it becomes necessary, weed out, those that are found not to have it.

That this is practicable appears from what has been already effected. I will say nothing of our societies, though I think it is safe to assert that to be a member of either is *prima facie* evidence of integrity. I prefer a reference to the graduates of West Point, whose high tone has, with a few melancholy exceptions, carried them with unsullied reputations through temptations to dishonesty by which most other men have been overcome.

Whether or not this end can be fully attained, or whatever should be the exact steps towards it, it should always be kept distinctly in view. One uppermost thought may here be presented, not suggesting any action by these societies, for that would be outside of their province, but for the consideration of each individual member. Most of us doubtless agree with the solemnly expressed opinion of

our own venerated Washington, that the only sure foundation of morality, and of course of the high-toned integrity that is so essential, is the Christian religion.

PROF. FAIRMAN ROGERS, *Member of the American Society of Civil Engineers.*

MR. CHAIRMAN: I shall naturally be disposed to treat the subject under discussion from the point of view of an instructor. Formerly Professor of Engineering in the University of Pennsylvania, and subsequently taking an active interest in that particular department of the University, the consideration of the subject has necessarily been constantly forced upon me. I have given it much attention, with the result, that apparently a great many of us have reached, that it is a very difficult question, and that it is almost impossible to come to a positive decision upon many of the points which present themselves.

We all so far seem to agree upon one point, however, and I most heartily indorse the expression that has been given to the opinion, that a broad, strong basis of cultivation is necessary to enable the average man to obtain a reasonably high position in the profession. We must leave out of consideration those men who, by wonderful genius and energy, or by extraordinary advantages of connection, attain a position which is not within the reach of the ordinary man.

In technical schools, such as the Towne Scientific School of the University of Pennsylvania, we should aim at teaching the underlying principles of science generally, and the application of special sciences to that branch of practice to which the student is directing his attention, with the greatest possible thoroughness. There is in my opinion a disposition in all our schools and colleges to teach too many subjects, and an attempt to spread the time and effort of the student over too wide a range.

That cannot be attended with satisfactory results, and I believe that we shall do best by adopting a small number of studies, very carefully taught, and reiterated in such a way, that the fundamental principles which underlie all the arts and sciences shall be thoroughly understood by the student, and shall have become an integral part of what we might call his mental life.

In my opinion the time at the disposal of the student, before he enters upon the actual practice of his profession, can be best employed in the schools, without practical work, further than the small amount which may be necessary to fix in his mind the theoretical principles

which have been presented to him, provision for which can be made by very simple workshops and laboratories under the control of the professors. Beyond that, I doubt very much whether the attempt to combine practical with theoretical instruction gives an equivalent for the time spent, and I believe that the interruption of the course by a year or two years of practical work in a shop or in the field would not in the main be attended with any satisfactory result. Habits of continuous study are formed with difficulty, and should not be broken in upon until the time arrives for them to be exchanged for habits of work.

The industrious student may, with undoubted advantage, spend his vacations in each year of his study in such observations of practical matters as he may have opportunities for, a course which will result in fixing in his mind very strongly the principles presented to him by his text-books and his instructors.

There are so many things that can be taught properly only in the regular progressive methods of the schools, such as pure and applied mathematics, and mechanics, and the like, that there seems to be every reason for embracing the opportunity which can never occur again, and requiring the student to devote his time exclusively to such subjects.

Once launched into the hurry and excitement of practice, the young man finds the systematic pursuit of such knowledge difficult, if not almost impossible.

Other subjects in the same category are those based upon the digested experience of many investigators, which, though to a certain extent empirical, and wanting the logical completeness of mathematical investigations, must be adopted as embodying the principles which underlie practice.

Belonging to this class are the laws of the regimen of rivers, the action of currents, and the flow of tidal streams, or the various matters of shop or constructive practice which a man must know thoroughly at the very outset of his career, and which have been reduced to form by the labor of hundreds of individuals.

We may be assured that the young man who goes out into the world with an entirely thorough theoretical education properly given to him by competent, progressive, live instructors, will be in a position in which he cannot make serious mistakes, and from which he will surely in the long run distance those competitors who are less thoroughly prepared.

The absence of an exact knowledge of the principles which un-

derlie practice is, I think, painfully apparent in the larger number of so-called practical men, and while we constantly hear the practical man regretting that he has not had the opportunity of obtaining that theoretical knowledge which appears to him to be so desirable, we rarely hear the man whose theory has preceded his practice complain in the opposite direction.

In a case that came under my notice some years ago, a portion of a new building was covered with a half-span, lean-to, iron roof, from which was suspended a light ceiling which hid the framing from view. With the first heavy fall of snow of the succeeding winter the roof fell in, and the removal of the ceiling disclosed a curious condition of affairs which accounted sufficiently for the accident.

The contractor being sent for, expressed unbounded surprise, and insisted that, as he had put up several *whole*-span roofs, from the same drawing, of eighty feet span, this *half*-span roof of only forty feet ought to have been unnecessarily strong, and it was difficult to explain to him that, by cutting his drawing in two, he had converted an inch and a half round iron tension rod, which was amply strong, into a compression piece which was useless. In my opinion no properly educated graduate of an engineering school, in his first year of practice, could possibly make *that* mistake, and yet I am certain that similar things, coming out of well-known workshops, will present themselves to the minds of many of my hearers.

A similar case is stated to have occurred in England, where some wise individual attempted to give additional support to a whole-span iron roof which was thought to be rather light, by inserting a row of columns under the centres of the principal rafters, with the same satisfactory result.

In individual cases the precise method of education may be modified by the peculiar connections of the student giving him extraordinary facilities in certain directions, but I would sum up my remarks by saying that the best time for a young man to acquire a systematic knowledge of the fundamental principles of his science is while he is in the school, and while he is attending to what is usually called his education, and we may feel assured that he will rapidly overcome whatever temporary disadvantages he may labor under in the outset of his career for want of practical knowledge, and in a thorough and scientific manner apply those unchanging principles which have sunk into his mind and become a part of his professional nature.

THE CHAIRMAN: Gentlemen, I think it is only fair that the individual who caused all this trouble by his words, and set the two societies by the ears, and brought all of us together here to debate and discuss, and shed various lights on the subject that he has made prominent, should have a chance along with the rest of us, in the general fray, and therefore I shall presently call upon Mr. Holley to make his contribution. I ought to announce, that after Mr. Holley's remarks we shall adjourn, to meet again in this place at 10 o'clock to-morrow morning; and before he begins, I must assume the chairman's privilege of speaking without leave, more than his share, in order to emphasize one or two things which this whole discussion has brought out. It has been a very remarkable discussion in some respects. The unanimity of feeling in one particular has been manifest, namely, as to the value of broad and general culture. This is very agreeable, because it shows that all the engineers are in favor of that thing; yet I may say that the parents in this country as a class are just the other way. When an American father talks of putting his son into any special profession he says, "I am not going to send my son to college, because he is going to be an engineer. I will take him out of college." He says, "My son is going to be a merchant; I will take him out of college;" and parents are all the time pulling their sons out of college because they are going to go into some special line. As I say, the tendency on the part of fathers is exactly contrary to the tendency on the part of experts. When a man happens to be both an expert *and* a father, like my friend, Mr. Sellers, then the boy gets a wise preliminary training. But he has put his boy into his own line, and he understands what is necessary in that line. It is not difficult for a hen to bring up her chickens; it is when the hen hatches a duck that the trouble comes in; and it is the fathers who are ministers, doctors, and lawyers, who have seen some young men rise to wealth perhaps in engineering, and have got a vague notion that it would be a good thing to make engineers out of their sons, it is such fathers who are apt to think they must take off a portion of the general culture, because they fancy it does not require so much general knowledge to enter the engineering profession. They may be the soundest men on other subjects, but they know nothing about engineering. This subject has been condensed by my friend, Dr. Wedding, in a single phrase which was carelessly thrown out in his remarks, and which, perhaps, he did not consider specially significant to us: but it was very much so. When sketching the career of a young man

coming into life he said, "Well, then, at about twenty-five or twenty-six years of age, it is about time to begin to look about for some means of supporting himself, so that, when he gets to be thirty years of age, he has a place in the world." We would think it was too much to expect a young man to wait until twenty-five or twenty-six before he actually cuts loose from the parental hearth. It is to the other extreme that we go, and the young men of this country set out in life with too hasty a preparation—crammed, instead of trained at a much earlier age.

One word more in regard to the suggestion of Mr. Welch concerning the value of general practice and general acquaintance with all the branches of practice on the part of the engineer. Everybody knows how hard it is to keep up in all branches and be master of all the branches. It used to be possible years ago, but it is not possible now. No one can do anything like keeping up with the progress of the science of the present day. Humboldt was, perhaps, the last living man who kept pace with science in his race. It is not because we have not men of great mental power at the present day, but because the circle of knowledge has grown beyond the capacity of the single mind. Yet there is always a certain ability of comprehension in a man who has become a master in one department. At the same time he may keep up a general acquaintance with other departments, and be an appreciative listener and helper to the specialties in other lines. I only mention this because it is worth emphasizing that our technical societies are admirable agencies for maintaining this general acquaintance by agreeable social methods. As to the matter of integrity, spoken of by Mr. Welch, I would suggest that it ought to include more than financial integrity. Of those who are employed in a subordinate as well as in leading engineering positions, the fewest number have to handle funds without any possibility of control. Where you trust a man with a dollar once, or a hundred dollars once, you trust him one hundred times with some duty, the conscientious discharge of which involves really a larger amount. We as engineers should have that peculiar variety of integrity which consists in strict military obedience. If this is wanting at the scales and at the tunnel head, we shall not know what is going into the furnace, and all our science elsewhere will be in vain.

I now call upon Mr. Holley to close this session.

MR. A. L. HOLLEY, *Member of the American Society of Civil Engineers and the American Institute of Mining Engineers.*

MR. PRESIDENT: I shall refer only to one of the topics mentioned in the circular, and I shall endeavor to maintain the proposition that technical education in works should precede technical education in the school.

Let us first clearly appreciate the proposition, and in so doing, answer the first and hastily considered objection that is often made to it. The proposition is not to send the uncultured youth into the works and then into the school, for the uncultured youth is fit for neither the works nor the school; but it is to send the graduate of the high-school, the young man of good general culture, well founded in mathematics and in the principles of physical science, first into works, that he may there learn from nature and from the actual possibilities of labor and cost, the farther value and direction of technical studies. What we are so often told, that the mere common-school boy, or the machinists' apprentice, or the average mechanic in any department, will stick to his low place and in his narrow circle—that he would neither seek the technical school nor utilize its advantages if he did seek it, may be perfectly true, but it does not affect the system under consideration. In this system there are three distinct elements; if one is wanting the whole fails.

1st. The high-school, the liberal general culture to acquaint the mind with the history of human endeavor, and more important still, to discipline it in the methods and habits of scientific thought. Without this fundamental culture, the average man—I beg of you not to keep calling up in your minds the exceptional cases—without this culture, the average man will always keep in his low plane and his narrow circle, whatever his occupation. To him, practice will teach nothing but skill, and the strictly technical school will be as an unknown tongue. I presume this much will be universally admitted, certainly it cannot be doubted, when we see the thousands and tens of thousands of young men, who never rise above the lowest stratum of mediocrity, not for the want of average ability, but for the want of that ambition which general culture inspires, and for the want of scientific *methods*, without which high achievement is but the exceptional prerogative of genius.

This much being admitted, the second element of our system, is practice in works or in the field. At this point, two diametrically opposite courses are advocated. We hold that practice is now necessary to fit a man for the strictly technical school. Our opponents

hold that the strictly technical school is necessary to fit him for a course of instruction in works. In order that there may be no misapprehension of our position in this matter, I take the broad ground, and I call upon the majority of men who have made engineering what it is in this centennial year, to bear me out in the assertion, that at *this stage* of a young man's culture, the strictly technical curriculum of books, is not only useless, but positively noxious. I do not mean mildly wasteful of time, but positively disseminative of error, the marks of which can never be effaced. Let it not be supposed that we undervalue the technical school, on the contrary, if time permitted, we would quite as strongly oppose the equally absurd practice of neglecting at the proper time, the abstract principles, the formulated results and the refined methods, which can only be acquired in the school, and which can only be acquired in a manner helpful to practice and to progress, when a touch of nature has revealed their significance.

To illustrate the noxious effects of beginning a technical course with abstract principles and with whatever is formulated in books: It will not, I think, be questioned by experts, that the grand elements of success in the management, for instance, of metallurgical manufactures, of machine building, of steam propulsion, of constructive engineering—elements far exceeding in importance the mere calculation of strains or the mere analysis of materials, both of which can be bought like the materials themselves—that the grand elements of success in making all these engineering enterprises *pay*, are an intimate knowledge; 1st, of what, and how fast, and how long, and at what cost, the tools and implements and processes at hand will *do* what they are set to do; 2d, of what iron, and steel, and brass, and materials in general may be relied on to stand, not under uniform stress as laid down in the tables, but under friction and heat and vibration and multiform stresses, and all the variations of quality due to imperfections of manufacture; 3d, of cost as modified by all the risks of waste and loss by varying refractory materials, by breakdowns, by facilities of transportation; 4th, of economy as promoted by keeping all departments of manufacture and construction in harmonious operation; 5th, and most important of all, of the management of labor, founded on the knowledge of what labor may be expected to do under all the influences of trades-unionism and bonuses and lockouts. These are things which the young man who proposes to educate himself for leadership in engineering may not indeed know at once, with that nearness of knowledge which makes the

expert, but unless at the very outset of his technical course, in the novice's first period of susceptibility, his mind is moulded to grasp the great facts of his profession in the concrete, as existing in the subject itself, then the abstract as imparted in the schools will acquire a precedence in all his mental processes, from which he can never be emancipated. This is the reason why the men who actually manage engineering works to-day, are so largely sprung from the ranks, despite their want of scientific training, while so much noble culture is year after year following after the phantom of abstract principles as dissociated from the subtle and ever-changing aspects of nature.

I would further express the belief, contrary to the opinion of an expert with whom it is almost presumptuous to differ, that this concrete knowledge of the profession cannot be formulated any more than—if I must use a strong illustration—than Ovid could adequately formulate the art of love. No book can impart it, no formula can give it vitality; nature with all her subtle processes must prepare the ground, and then the schoolman may plant his seed with hope of harvest. Shall the average student satisfy the conditions of progress with the book, when Tyndall and Henry, Faraday and Agassiz, threw away the book and penetrated the inmost tabernacles of nature?

The student may indeed study in works, after he has completed his course in the school, but his mind has then been so saturated with general principles and theories, that he is positively unfitted to appreciate the great considerations of cost and policy. Let me repeat this fundamental truth—the first impressions received by a mind virgin to technical training, especially the impressions ingrained by a course of books, will inevitably mould its whole future. If a man at first imbibes, for instance, the idea that certain formulæ of strength cover all cases of engineering construction, or that the known principles of chemical affinity will give him working conditions under all changes of temperature, then he comes to regard this teaching as the law, and all variations from it fill him with doubt, perplexity, and discouragement; while if he first learns from practice, that the complete law is as yet unwritten and unknown, that the first principle of success is to lie close to nature as she reveals herself both in inanimate materials and forces, and in the developments of humanity, he will not be baffled and disappointed at apparent exceptions to general laws; he will rather be stimulated to search the books, in order to draw conclusions from wider ranges of facts, and to avail himself of the methods and conclusions of other observers.

The teaching of books, however important at the proper time, is nevertheless one-sided, partial, and incomplete; the teaching of objects and phenomena can impart no error, but it reveals all those conditions under which theory and general conclusions must at last be tested.

That men of general culture who have been trained in practice, do not only seek the school, but hunger and thirst after the wider facts and formulated results laid down in books, is a notorious fact, and the reason is that such men alone can appreciate and utilize the school.

This bring us to the third element of our system; the technical school *after* some practical training has opened the mind to its advantages, and protected it against misconceptions. This subject has already been discussed.

To sum up the whole matter, let the student first survey the ground, and then plan his structure; let him first observe that all so-called laws in physical and natural science are in constant process of modification, as nature gradually reveals herself, and then he will spare himself the mortification, and he will spare the public the damage, of trying to square nature to the book.

TUESDAY, JUNE 20TH.

THE PRESIDENT, DR. RAYMOND, called the meeting to order, and introduced Mr. Boller.

MR. A. P. BOLLER, *Member of the American Society of Civil Engineers.*

MR. CHAIRMAN: The mere fact of our meeting here on this occasion, as practicing engineers, to discuss, out of our experience and observation, the subject of "Technical Education," is sufficient evidence that technical schools fall short of accomplishing the objects for which they have been instituted. Before giving, however, my views upon the specific topics named for the discussion, I am constrained to state briefly my conceptions of the principles of education, and in a measure the conditions limiting their application.

Education, in general terms, aims to discipline the mind in correct methods of thought, through the study of the best fruits of human experience and knowledge, and so to better fit the recipient for taking part in the general struggle for existence. It has two principal divisions, viz., liberal education, or the education of culture, and spe-

cial education, which undertakes to select some one branch of knowledge, and pursuing that to the exclusion of all others, to make the student valuable to that portion of society having need of such special knowledge. The former is preparatory, while the latter is the culmination of educational training. In the one, knowledge is secondary to mental discipline; in the other, mental discipline is secondary to knowledge.

The "technical school" is a special school of comparatively recent establishment, growing out of the demands of a peculiarly commercial civilization, and is valuable to the community just in proportion to the degree to which its graduates have mastered the facts and bearings of scientific observations, with their application to useful ends. Thus far those under whom technical schools have been developed have been to a great extent theorists in educational matters, and so keeping their minds fixed on the abstract side of the question, have lost sight of the realities of every-day life, and the limits imposed by a very complex state of society.

An unquestioned difficulty in blocking out a satisfactory method of technical study is the absence of any national system of progressive education, by means of which students may be brought to the same plane of preparation for entrance to the technical schools—a deficiency which will probably always exist in this country, owing to the peculiar nature of our political institutions, and which must be faced in any remodelling of methods that may be undertaken hereafter.

Theoretically, the technical school is highly practical; practically, it is highly theoretical. A strong infusion of practical knowledge, that is, the knowledge derived from observation and experiment, with a corresponding reduction of pure theory, would serve the end to be attained by a technical education much better than as now conducted. It must ever be borne in mind that the office of the technical school is not to produce scholars, professors, or mathematicians. Beyond a certain point, theory, for the mass of students, is a waste of precious time (particularly that region of theory built up without fact or experiment), the limit being defined by the requirements of actual practice. Some few, and only a few, are capable of absorbing the highest developments of mathematics or physics, and such will follow the bent of their genius, curriculum or no curriculum. It is notorious, that as a rule, the tone of mind of that class of students is such that they are illy fitted for business relations, their natural calling being in the purely intellectual field of original

research; and in this place they have a very important niche to fill in the economy of divided labor.

The principle of divided labor in the operations of society is of increasing importance yearly, and no technical scheme of education can meet the wants it aspires to fill, without giving full weight to this law. There is, in these later days, too much to know in any one branch of knowledge, for one mind to compass it wholly. There can be no more Humboldts, and the day has long passed since the engineer was supposed to be equally capable in all departments of the profession. Any one department is more than a life's study for the best of us, and while it is right and proper to have a certain amount of generalized information, eminence is attainable in only one or two directions. It is as an *expert* in some one subdivision of professional knowledge that the modern engineer makes his mark, whether as a hydraulician, mechanician, a manager of mines or of railways. In the enthusiasm of scientific devotees they are too apt to base all methods and systems of instruction on the idea that the mass of students will pursue science for the sake of science. They forget that the profession of the engineer partakes more of a business character than any other, that it is anything else than an ornamental calling, and that the civilization which has developed it is one of gain and personal advancement.

There are almost insurmountable difficulties, such as attend no other branch of special education, which present themselves when we attempt to outline a complete system of technical education based on practice or experimental research. There is no way by means of which students can be graduated engineers, in the same sense, for example, that schools of medicine or of theology can graduate doctors or parsons. The former have the adjuncts of the hospital and dissecting-room, while the latter, being schools simply of opinion and dogma, require nothing beyond the teaching of men trained to transmit these special opinions and dogmas. To graduate technical students on relatively the same plane as is done by the schools of law, medicine, and theology, has thus far been the ambition of the theorists who are responsible for the present system of technical education. This is shown by giving degrees instead of certificates at graduation. It is not theory that makes the engineer, but practice, in the shop, in the field, or in the mine, and the difficulty of incorporating such practice in the curriculum of instruction appears to be insurmountable, except, possibly, in some minor divisions of engineering study, such as surveying and minor geodetical operations.

It has been suggested that the "shop" should in some way be added to the regular course of instruction, either preliminary to, or succeeding, the theoretical training, and Mr. Holley has even proposed, with some degree of enthusiasm, "to establish organized schools in the various existing works." I have very little faith in the accomplishment of such an adjunct, desirable though it be, at least in any systematic manner. There is no doubt that many students, if so recommended, will avail themselves of opportunities to enter the "shop" in an individual capacity as apprentices, but to expect that any scheme can be devised to incorporate as a system, the workshop idea in the curriculum of a technical school is, to my mind, utterly out of the question. Mr. Holley's recommendation, persuasively as he puts it, is too dependent upon mercantile philanthropy, and involves a harmony of action between the schools and the owners or managers of works hardly to be expected this side of Utopia. There are two ways, however, in which the essential benefit of shop association can be had by the schools, and they are either to make a certain preliminary artisan or field training essential to matriculation, or to require a certain amount of such experience after graduation, as essential to a degree. The former course would seem the natural inductive method, as the student would commence by observing facts and phenomena, not only of material objects, but regarding the methods and habits of men with whom he will have so much to do. To a mind filled with the facts of nature, theories founded thereon have a value of application and a depth of meaning impossible to one who is purely book-prepared. To observe first and generalize afterward is the philosophy of modern progress and discovery, and it would seem to be simply following that inductive system in giving an affirmative answer to the first part of the first proposition of Mr. Holley's circular. There is, however, a serious objection to such preliminary practical training in the mechanical branches of engineering, and that is the moral effect upon youths at probably their most impressionable age, associated as they must more or less be with the rough working-man and mechanic. The injury done to their character might outweigh any benefit they derived from the opportunity of practical observation. If this objection is regarded of too serious a character to be overlooked, the only alternative is a post-graduate practical course, for I throw out of consideration the toy workshops of the schools themselves. Mr. Holley is quite right when he says that a school of engineering practice, based upon faculty control, "can be nothing less than a vast

and successful establishment for construction and operation in nearly all the departments of engineering." That, of course, is impossible.

Many young men do substantially take a post-graduate course, which might be made almost compulsory on all students, and thus indirectly part of the school system, if degrees were withheld until the student gave *proof* that his post-graduate experience was such as to entitle him to be ranked as an engineer. The present method of graduating young men as full-fledged engineers is not only a perfect farce, but it also gives the graduate a very erroneous idea of the profession he is about entering. It cannot be too strongly insisted upon that the school cannot make an engineer, even if it crams him with all the book learning of technics. It can with perfect propriety give a young man a certificate that he has had a certain training, but he is entitled only to the term *engineer* when he has enough experience in manufactures, mines, or public works to qualify him at least as a capable assistant. The post-graduate system commends itself to my judgment as the wisest one, not only on account of moral maturity of character that a student of the average graduating age is expected to have, but also because the effect of a year or two of preliminary shop practice on the general run of boys would be fatal to habits of study. The exceptionally bright and ambitious youth would no doubt derive the immense advantage of the inductive system before referred to, and enter the school from the shop with a mind singularly well prepared for grasping the laws of scientific relations, but the average boy is not inclined to study, is not particularly ambitious, and in all probability would not reach the school at all. Once in the shop, he will in all probability conclude that he can get there all he wants to carry him through the world, he gradually ceases to study after hours, and so losing the habit, is satisfied, after his apprenticeship is finished, to take his stand in the broad phalanx of the rule-of-thumb members of the profession ; or, what is quite likely, avenues of earning wages will be opened to him, and he may deem it too much of a sacrifice to sever himself from such attractions.

Upon the second topic presented for our consideration, viz., the connection of experts with technical schools, I have long held positive views. It seems to me an anomaly in technical education to abandon its methods and direction to those who have either had no experience in technics, or experience in a very limited degree. If engineering is anything, it is a practical science ; it is the "art of directing the forces of nature to the service of man," and being such, it is the business of the schools undertaking to teach it, to show as

far as possible how those forces are really controlled and applied, as well as their nature and laws of operation. This last the mathematical and physical professors can do very well, but the former can only be properly taught by the expert, familiar not only with principles but practice. If schools of law or of medicine cull their lecturers and teachers from those most skilled in the practice of their respective specialties, how much more ought our engineering schools to select for their chairs of applied science, men who have had experience as practicing engineers?

There are things, little things, perhaps, in themselves, but often keynotes to the comprehension of a subject, that the books cannot treat of, and the professor who depends upon what the books say for his practical teaching cannot appreciate their importance. The proper and feasible way, in my judgment, to incorporate the expert idea in any technical systems, is in the form of lectures as part of any given course, such lectures being confined purely to the engineering practice of, or the specialty of the lecturer, the lecturers not to be part of the resident faculty, but practicing engineers, able to devote a week or two in each term to an exposition of the methods and operations of practical engineering. This can be done, too, without trespassing upon all that is valuable in the theoretical portion of the technical course. As now administered too much time is given to abstract mathematics, and in some of the schools it is carried to such an extent, that the student, if he is not utterly befogged, becomes saturated with the idea that mathematics is the Alpha and Omega of the engineer's profession, and that he is the best engineer who is most expert in devising intricate formulæ and mathematical transformations. This is the natural result of what may be called the engineering of the schoolmaster, who tells us that the mental discipline and logical methods engendered by extreme theory are of immense importance to a young man desirous of practicing the profession of the engineer, and that the mathematical pathway is the surest road to eminence and success. Now, regarding the first claim, it elevates discipline at the expense of knowledge; as to the second, it is so far from being a sure road to engineering success as to be almost an educator of blunders, by giving a fictitious importance to the value of purely theoretical deductions. Engineering, having to do with natural facts and phenomena of ever-changing characters, must generalize knowledge from experiment and from the laboratory, and not from the hypothesis of mathematics. I do not wish to be understood as despising theory, but the conditions of practical

life are such that to the average student, beyond a certain training in elementary principles, theoretical discipline is a waste of valuable time that could serviceably be spent in the accumulation of practical experiences and the observation of phenomena. In my preceding remarks I have not touched upon the matter of general culture, which I hold to be important to the success of the engineer, and I heartily indorse all that Professor Raymond has said upon the subject. I would say, in conclusion, that I look for any modification of the present system of technical education in the direction of a reduction of the amount of theoretical instruction, the introduction of a system of expert lecturers, a systematic study of experiments and their bearings, and the withholding of degrees until a student has qualified himself by a course of post-graduate experience. As to general culture, it should form part of the matriculation requirements, and not be attempted directly in the technical curriculum. The extent of this culture is to be as broad as possible, equal to that of the average college or high-school graduate.

Beyond the directions here indicated, I do not believe that the technical schools of the country will find it practicable to modify their systems and courses of instruction.

THE CHAIRMAN.—A gentleman, who I am sorry to say has been obliged to leave us to-day, Prof. Cook, the State Geologist of New Jersey, and the head of a very efficient though not very extensive school in Rutgers College, who began life as a practical engineer, and has been more or less in that work ever since, mentioned to me before leaving, his regret that he had not spoken last night, for the sake of bringing forward something that had engaged his attention for twenty years, and that seemed to me, as to him, to be one of the most immediately practical steps towards a needed reform. If Prof. Cook had remained, he would have been pleased to find in the paper just read, a forcible presentation of the point in which he was so much interested, that is, that the granting of degrees to civil and mining engineers should be made to depend upon their post-graduate course, and that the degree upon graduation from the school should be simply that of Bachelor of Science. That is almost exactly the idea Mr. Boller has brought forward. I will now call upon Mr. Coxe, of Drifton, Pa.

MR. ECKLEY B. COXE, *Member of the American Institute of Mining Engineers.*

MR. CHAIRMAN: I have been asked to give my views upon the

subject of Technical Education with special reference to mining, and although a member of the committee who prepared the programme for the speakers, I think I shall follow the very sensible course of most of the gentlemen who have preceded me, and ignore the aforesaid programme altogether.

One of the first questions that suggests itself when we begin to reflect upon this subject is (as I stated at the Washington meeting of the American Institute of Mining Engineers), "What is an engineer?" or "What do we wish to produce" when we submit a boy to the best system of technical education we are acquainted with? The tendency to-day is to make the ordinary workman a specialist, to teach him to do one thing well, or to work on one machine well, and then to keep him at that for the rest of his life. In old times a machinist, for example, worked at all sorts of jobs, and with every tool in the shop, and thus became practically familiar with all the details of the trade, and if he was a man of more than ordinary ability and industry, he might rise to be foreman, and afterwards director or engineer of the works. But a man who works all his life at one machine only, will undoubtedly become very skilful at that sort of labor, but will not be likely to acquire such knowledge as would fit him for the position of foreman. The fact that all the workmen are specialists, requires a higher grade of instruction and intelligence in the foreman. The workmen do not and cannot think for themselves; they must do exactly what is set before them, without any regard to what is to become of the work when done. Now the foreman should be a man well up in the theory and practice of the construction of machines, and he should have first-class theoretical training, and also first-class shop training upon all the machines and at all kinds of work; in other words, he should be an engineer, a man who understands theoretically and practically the laying out and carrying on of work; one who, when he has made the plan of a machine, a bridge, a furnace or a breaker, knows if it can be built or not, and how to direct the men who do the work. To obtain such men shop training is necessary, and the number that will be wanted is increasing. It seems to me that the standard of work is higher than formerly. Then the only requisite for a bridge or machine was, that it should be strong enough to do the work required, or to resist the strain to which it was to be subjected; now it must be constructed not only with a view to proper strength, and distribution of material, and adaptability to the work it is to per-

form, but also with due regard to its appearance. Great ugly masses of iron without architectural effect are no longer tolerated.

This requires a certain amount of æsthetic culture in the engineer; for that reason I fully concur in the opinions which have been expressed as to the importance of giving a liberal education to the student of engineering before he commences his technical studies. We all agree that a thorough general education should be given to a young man before he enters the shop, and the only question is, should shop work precede, accompany, or follow the theoretical studies?

My own opinion is, that a year's training in a machine shop, previous to entering upon his purely technical studies, is of the first importance to any young man about entering any branch of the engineering profession, provided he has had drilled into him, in his liberal education, enough of the fundamental laws of nature to prevent him from being affected by the shop superstitions, as I may call them; in other words, he should know that there is no effect without a cause—that when a man tells him (in referring, for example, to a machine) "*she works badly*," "*she takes fits of working*," etc., he must understand by it that some part of the machine is out of order, or not properly constructed. If the machine does not work right, it is because some man has not done or is not doing right.

I remember when I was about twelve or thirteen years old I tried to construct perpetual motion. It was very simple. I made a small water-wheel, and attached a very primitive pump to it. The pump was to raise the water to run the wheel. I was totally ignorant of the principle of the conservation of energy; if I had not been, I should not, of course, have attempted any such absurdity. Had I entered a shop in my state of mind at that time, I should have imbibed false ideas which it would have been difficult for me to free myself from afterwards. These remarks apply with more force to such complicated structures as furnaces. They are generally thought of and spoken of by the workmen as living beings, subjected to fits of good and ill-humor, instead of being simply large chemical apparatus.

I think it important for a young man to be thoroughly grounded in the principles of mechanics, physics, chemistry, and mathematics, so as to know what is possible, as well as what is impossible, before beginning practical work. I find in the practice of my profession that in many cases it is of very great use to me, to be able to say decidedly, "It is no use to try to do that; it is physically and math-

ematically impossible," and every engineer has suggestions made to him which are physically and mathematically impossible. I do not believe that the success of some of the most distinguished engineers can be adduced as a proof that one method of training is better than another because they were trained in a certain way. What we want is the best method for the greatest number of average minds. We all know that such men as Watt and Stephenson would become able engineers under any system of training.

There are others again of whom no system of education would ever make engineers. The point is, to produce the best marketable product with the available material. One of the gentlemen who preceded me said that a boy when he went into a shop might like the work, and prefer to remain and get good wages instead of going back to school. No doubt we will often meet with such cases, but I think the best thing that boy could do would be to stay in the shop, for by taking him away we might make a poor engineer and lose a good mechanic. I do not think the objects of our schools should be to turn out the greatest quantity of engineers.

I now come to the point upon which I was requested to speak, and I shall be brief. If a young man wants to study mining engineering, he can easily get a place about a mine where he can learn much that will be of use to him afterwards, without interfering in any way with the running of the works. Where there are corps engaged in surveying the mines, if he is willing to work day or night, where it is clean or where it is dirty, he will always be able to get employment as a chain carrier, etc., for there are always in the mining corps one or more men who are simple laborers, and a willing young man of intelligence could always take the place of such a person, and learn a very great deal, not only about the methods of surveying, but also about the way in which the works are laid out and carried on. If the young man has a certain amount of knowledge of drafting, trigonometry, etc., he can also make himself useful in plotting and calculating the surveys, and he would, of course, learn much more himself.

I think, however, as I said before, that at least a year's training in a machine shop is of the first importance for all students of engineering, mining engineering included. A thorough knowledge of machinery is of the greatest use to the mining engineer, whether he be located near to or far from machine shops.

I have always regretted that I did not work longer myself in a

machine shop. There is no trade requiring such familiarity with accuracy of measurement. The intimate contact with the workmen gives the student a knowledge of their ideas, feelings, and ways of thinking, which will be of great benefit to him when he comes to have men under him.

If I were asked to advise a young man who had received a liberal education, and who wished to make himself as *useful* a mining engineer as possible, as to his course of study, I would tell him:

1st. Work a year in the machine shop, foundry, drawing-room, or blacksmith shop of a small shop doing general work in the mining region, before beginning your technical studies.

2d. While at the shop try to learn something about the mines in the neighborhood.

3d. During your time of study see such shops and works as you can, and spend one or two of your vacations in the corps of some mining engineer who makes surveys and does other mining engineering work.

4th. Study bookkeeping, and try to learn while in the corps, how the books and accounts are kept at the mines.

5th. When you graduate from the technical school, get a place, no matter what, at some mine, and if you are of the right kind of stuff, you will soon rise to be a really USEFUL mining engineer.

6th. Never despise *theory* or *practice;* both are equally important. Always try to know *how to do a thing*, and WHY.

7th. Try to make engineering a profession, not a trade—a thing to live *for*, as well as *by*—and do not let yourself get rusty even in those branches which do not seem to be of use to you in your business.

MR. WILLIAM P. SHINN, *Member of the American Society of Civil Engineers and of the American Institute of Mining Engineers.*

MR. CHAIRMAN: The special requisites in the education of the engineer, to which I shall refer, may not be considered "technical" by many, but their importance has been demonstrated to my mind in the course of my experience, and I call attention to them because they do not appear to be considered by professional educators as among the requisites, and because while other parts of this discussion will be committed to or assumed by persons far abler than myself, these particular branches of education are not so likely to receive the attention which, in my opinion, they merit.

I refer to, 1st, the science of accounts, and 2d, business forms and principles.

"Accounts" are, or should be, to the engineer, what history is to the statesman, the record of progress in a financial sense as history is in a political sense; and in many cases the chart indicating the shoals and quicksands to be avoided, the channels and roads to be followed.

"Business forms and principles" are as necessary to be understood by the engineer as by the lawyer, although they are not considered as forming part of the "technical" education of either.

Many engineers, civil engineers in particular, are so situated when in charge of important works as to be obliged to exercise functions both executive and administrative, and even sometimes and in some sense judicial. Like the captain of a ship, the engineer has frequently to be "a law unto himself."

Lack of knowledge of these forms and principles lead to many embarrassments and frequently to pecuniary losses. I have known an engineer of sufficient experience to have had charge of construction of an important division of railroad twenty or more miles in length, who, when the railroad company failed to pay its contractors and men, gave and accepted orders in favor of merchants, of which he kept no record, so that when the men, who were settled with before the merchants, got their pay, they were paid in several cases without deduction of the amounts of their orders, which orders having been accepted by an authorized agent of the company had to be recognized and settled, the amounts being a loss to the company.

The forms and general principles governing the law of contracts, ought to be understood in at least a general way by every engineer. His business is largely carried on through the medium of contracts, and the loose manner as to form, and indefiniteness as to understanding, in which agreements are often made by engineers, are the causes of many losses to, and much litigation with, their employers.

"We will make it right," is an expression very frequently used by engineers towards contractors in relation to claims for "extras," or alterations in plans, but with no definition of what is "right," it is scarcely to be wondered at that after the work is done, the parties can seldom agree as to the compensation. Such expressions are not businesslike; much less are they professional. Engineers should be men of precision; their technical education all teaches the value, nay, the *necessity*, of precision in measurements and in calculations, and it

should alike extend to their commercial transactions, to their business expressions.

But it is in the matter of "accounts" that many engineers fail most completely. *More engineering works are financial than physical failures.* How rarely is it that the cost of a work of any magnitude falls within, or even approximates, the estimate made before it was commenced. A notable instance to the contrary was the Croton aqueduct in its original construction, the cost of which (approximating ten millions of dollars), fell within *less than one per cent.* of Mr. Jervis's original estimate. How frequently, on the other hand, could the projectors know the actual cost in advance, would they have declined to make the investment. So universal is this experience that it has brought actual and merited discredit upon the name of "engineer." Why is this the fact? Partly because engineers are not *precise*, but mainly because they do not keep "accounts" worthy of the name. If they and their predecessors had kept strict and rigid accounts, properly classified, of all expenditures upon similar works, they would have had records which would have been a guide for estimating the cost of future undertakings of the same character.

But the so-called "science of accounts" (for it is after all only a pseudo science) appears to be a "bugbear" to engineers generally, and yet nothing is more easily understood if the engineer will only bestow upon it that attention and give its principles that analysis which he so constantly is compelled to use in the line of his profession.

Early in my professional experience I heard an eminent civil engineer, then in charge of the construction of an important railway, say with satisfaction, if not with pride, "I have nothing to do with the finances or accounts." Yet he was the only man in the general management with any experience or technical education in regard to railroads. What wonder, then, that the road, estimated to cost about two million dollars, cost between four and five millions; or, that its accounts intrusted to unprofessional hands and without intelligent supervision, fell into confusion, and that the company after paying dividends for four or five years defaulted in its bonds in the next two years and had to be "reorganized?"

Another eminent railroad man, himself a graduate of West Point, used to declare that "accounts are an invention of the devil to cheat people with!"

The principle governing "bookkeeping," as it is technically called, is as simple as it is universal, and every engineer can and should

understand it thoroughly. But accounts in general are not book-keeping in form, but rather in the form of records or abstracts, and it is in this form that they are most valuable to the engineer. In this form records can be kept which are not only valuable as showing where the money went, but they serve as beacons to warn the capitalist from too costly undertakings, and as guides to the engineer for estimating and constructing, and to some extent thus enable him to get at a measure of economy in the prosecution of his works. Such records, it is almost needless to say, are rare in this country. In an experience of over twenty-five years with public and private works, and an observation extending over many enterprises in the management of which I had no part, I have found such records to be the rarest exception.

Until this is reversed, until engineers are taught that they are responsible for economy in cost of construction, that economy cannot be attained without rigid accountability, that responsibility cannot be located without adequate accounts and records, and that it is the engineer's business to direct and supervise their keeping—until this condition of things is reached, we shall look in vain for that confidence in engineers' estimates and in the economy with which works have been constructed, to which the profession should be entitled.

PROF. THOMAS EGLESTON, *Member of the American Institute of Mining Engineers.*

MR. CHAIRMAN: It is certainly remarkable that among all speakers on the subject of Technical Education, there should have been but one opinion with regard to the necessity of previous culture before entering a technical school. It is all the more remarkable that the idea should be so prominent in the minds of so many engineers, when the practice seems to be to introduce young men to professional schools as rapidly as possible, without much previous culture. The highest possible previous culture seems to me to be an indispensable requisite. In the technical school the student has very little time to acquire anything but what strictly belongs to his education there. It is true that the amount of discipline which he gains from thorough training in the different branches of engineering will be of service to him, but he needs culture before he enters, for culture implies habits of thought, and no person needs these habits more than the student in the technical school. We are all of us creatures of habit, and it is therefore necessary that we should

not only form habits of doing right, but also of thinking right. Such habits as these *must* be acquired before the profession is entered, and should be before the technical education is commenced. Once in practice, there is no profession in which the necessity to have a correct judgment, and to act on it quickly, to think, and to think rapidly, is more imperative. Accidents are constantly occurring about the mines and furnaces which require instantaneous decision, and therefore the exercise of immediate judgment. If the early habits have been right, the engineer will think right from habit. If he has been accurate as a student, he will probably be accurate as a man, and for that reason he should have not only the highest possible preliminary education before he enters the technical school, but the very best after he enters it, and this education should include the higher mathematics, as being one of the essential means of learning to think accurately. I have been censured in my professional chair for demanding and exacting of the student the attainment of a thorough knowledge of the higher mathematics, but I have done so on the ground, not that he will in ordinary cases be called upon in practice to work out difficult problems, but that the mental discipline and the correct methods of reasoning which are given by thorough familiarity with mathematics, imply the likelihood of correct methods of reasoning and accurate judgment in other things.

We are very apt to think that the man who has learned the most is therefore the best educated and most learned man. It is sometimes said of men that they have forgotten more than their neighbors ever knew, as if this was a credit to the one or a discredit to the other. The best educated man is not necessarily the one who has learned the most, but the one who has his knowledge thoroughly classified, not overcharged with detail, but the detail so arranged that he knows where to find it when he wants it. The study of mathematics, when properly pursued, with other branches, gives such power of classification, that, even though it was to be little used as a sign language, it would be a valuable part of technical education for this reason alone.

Besides mathematics he should be able to use with a certain degree of facility at least two modern languages besides his own. If he can learn but one, it should be German, as being the one in which the greatest number of engineering works are now published by men willing to devote their lives to specialties, and in which an inexhaustible fund of information exists. If he can learn

two, the second should be French, as being the key to what was formerly done, and to what will probably be done again in engineering science. The acquisition of at least one modern language is almost an indispensable requisite to success. More important than either of these is the sign language, drawing. He should become as far as possible an artist in both free-hand and mechanical drawing, for, as a master of his pencil, he will be able to communicate his own ideas with his fingers, and to understand those of others which could not perhaps be readily expressed in words. I do not think that sufficient importance has been given to drawing as a means of expressing thought in our system of education. There is too much drawing done from models which is absolutely necessary to the beginner, but we do not require the student often enough to express *his own thoughts* by a drawing, just as he would be called on to express them in words. This could be accomplished in the same time that is now devoted to it, but would require a different system of instruction.

Dr. Raymond remarked at the Washington meeting that we had taken from the German university system everything except the time it takes, which is lamentably true. In this age and in this exciting climate we live in a hurry, we work in a hurry, and die in a hurry. We commence too young, enter our preparatory schools and colleges with too little preliminary training, and before we are physically and mentally able to comprehend what we are taught. Our high standard then, if premature, becomes simply a forcing system, and until we can do away with it, we make engineers on the principle of the survival of the fittest. It is no wonder that so many young men give out before they leave the intellectual hothouse, or occupy a medium position after they have left it.

It is undoubtedly true that all our technical schools would be in a much better condition if a part of the school course was thrown into the requirements for admission, and the age required for entrance advanced. I think that every faculty would be unanimous in this respect, and would consider that there would be a great gain in detaching from the course proper all of what must be considered purely preparatory work, and supplement it with advanced studies. This would have the effect to diminish the number of students, but to raise the grade of instruction. The opposition to this course would come neither from the young men nor the parents, but from the boards of trustees, who are apt to consider that the number of students in an institution is the chief if not the only real criterion of its success, while those of us who are engaged in education know per-

fectly well that numbers, instead of being necessarily a sign of power, may be a decided indication of weakness, though not necessarily so. Every faculty would agree with me, I think, in saying that it is far better to graduate one first-class man a year, than to graduate twenty indifferent ones. Unfortunately, there are but few institutions with endowments sufficient to feel justified in pursuing such a method, and fewer still who could divest themselves of the idea that numbers are in some way the best evidence of success. There may be no lack of ability, but to make up the average we often dilute that of a high order in order to keep up the lower grade. It is no just criterion to look at the expense per capita if five men of a high order were turned out where fifty of a lower grade might be. As a matter of arithmetic the expense is greater for the five, but as a matter of political economy it is really less.

The training of the schools should be such as to teach the young engineer how to acquire not only judgment, but as far as possible an independent one. This I believe to be one of the distinguishing characteristics of American technical education, while in some countries in Europe exactly the contrary is true, and the best reason that a young engineer can give is, frequently, "My chief told me so." No profession requires more judgment than that of a mining engineer. We have constantly something to do, and that something involves either life, present or future safety, present or future capital. The same problem rarely ever presents itself twice in the same way, and if the preliminary training has been such that we have acquired correct habits of thought, we probably shall carry the same into our profession, or at least be able to find out and correct errors before they have done harm. Mere facts are of very little use to the engineer of mines. We want not so much the facts, as the conclusions which are to be drawn from them, and since the data are rarely ever the same, we must act upon conclusions.

Dr. Wedding has hit the keynote of the whole subject. He wants his students to be able to settle at about thirty, and our students want to settle at about twenty-two. It is very true that, according to the old proverb, late marriages make early orphans, but it is also true that the average man has not acquired, or cannot have acquired, at the age of twenty-two or three, judgment or experience sufficient to justify capitalists in putting him in such positions as would enable him to settle and marry.

Many young men are in a hurry to complete their education, owing to lack of necessary means to prolong it, and the necessity

of commencing or being compelled to earn their living in some other way than the occupation of their choice, is often the reason why they commence prematurely. They feel, and with some show of right, that, in order to be established in their profession by middle-life, they must commence early. While this desire to hurry has been in some respects a disadvantage, it has been in others a real benefit to us. As a nation we are now just one hundred years old. The political necessities of the case demanded that our organization as a nation should be made in a hurry, and since we started in that hurry, what have we accomplished? There are but few nations in Europe who have as much to show in the same period. We have had no time to deliberate, for in many cases if we had taken time to deliberate, we should have taken still further time, and not made a move. Ten years ago we crossed this continent in stage coaches, a trip which cost three months after leaving the rail. We have recently accomplished that same distance by rail in eighty-eight hours. I had the good fortune to be present at the commencement of that road, and to see the first laying of one mile of track in a day. They were indeed in a hurry, but it was an organized and therefore a successful hurry. I think it may be said that where we fail, it is for the want of organization of this hurry. It may be said that, as a result of this method, many things that we have accomplished could have been better done, to which we may reply, that the necessities of the case have almost always been such, that, if what has been done had not been accomplished in this way, it would never have been accomplished at all, and therefore, even by imperfectly doing what might have been better done, if the element of time had not been that of which we had the least, we have not only benefited the present but the future.

It has been urged by many persons as a reason why the student should enter early upon his professional career, that education unfits a man for work if continued after a certain period of time, to which we can only reply that any system of education which unfits a man for work, or leads a man to despise or even to look down upon it, is a system which is fundamentally wrong. Labor is one of the best gifts of God. The man who is afraid to dirty his hands has mistaken his profession, and should be made to feel that he is out of his place and mistaken his calling. I had an apt illustration of this in my early professional experience, when four persons were selected from a prize examination to enter upon some difficult work requiring ability, judgment, and some little dirty work.

Their expenses were to be paid, but there was no other pecuniary reward; the honor of solving, or being selected to solve, the problem being considered by us all as a sufficient reward. Their intellectual merit was about equal; but when it came to the question of dirtying their hands, one of them presented himself in gloves, patent-leather shoes, and declined to put his hands into the dirt. As I look back after ten years upon the course of these men, I find that the one who was afraid to dirty his hands became disappointed, and left the profession shortly after he entered it, as it was evident that he had mistaken his vocation. The other three occupy distinguished positions in the profession.

One serious difficulty with students or young graduates is that when they enter the works they feel themselves to be the superiors of the workmen, and they are apt to patronize them, which the workmen resent. No one knows better than the workman that the student directly from the technical school, though he has the title, is rarely ever an engineer. He has simply acquired the a b c, and is ready to commence to learn to be an engineer. He has to learn what the workman is doing, and why he does it. The intellectual, and perhaps the social, superiority, the workman might be willing to admit, but he knows that the young man is entirely incapable of doing what he can do with ease, and therefore feels himself his superior, and he is right. We never cease to admire the skill of a good workman. He is a real artist who has learned from long experience to seize with the nicety of exactness the instant both of the commencement and end of reactions and changes which are entirely inappreciable to any but his educated eye. He has learned this from years of toil, and labor, and though he might not be able to explain them, he can always perform them with precision, while the student, if he has learned the reasons, is not able either to do the manual work or to distinguish between the different parts of a process. Any young man fresh from the schools who looks down on the working-man has a totally false idea of his own and the working-man's place. The two occupy a totally different position. The student can learn, and learn rapidly, all that the workman knows, and when this has been done, no one is more ready than the workmen themselves to acknowledge his superiority, and to sit at the feet of the very man whom but a short time before they looked down upon as an inferior. It is therefore a serious mistake for young men who wish to study to place such an antagonism between themselves and their teachers for the time being, as to prevent

their acquiring the information by placing an unnecessary barrier between the workmen and themselves.

There is one thing which it seems to me eminently desirable that we should introduce into our instruction, and that is the economics of the profession. It has been my own habit ever since I first commenced to teach to consider the cost of a process as the subject about which the most detail should be given, and to which the greater part of the instruction should be devoted. I have therefore made this the framework of my instruction, and have considered the theory of the process as the means of illustrating why the cost should be in certain cases greater or less. It has been my habit to define metallurgy as the art of making money out of ores, and to announce at the very outset of the course, that an ore was a material sufficiently pure and rich to allow of the metal being extracted from it with profit. By insisting that an ore is not an abstract thing, but that it represents labor and the value of the material used to get it, it becomes in the minds of the young men a concrete thing. They see at once that its value depends upon its being worth more than is spent upon it, and that if it is only worth what it costs to get it, there is no profit in working it. By introducing at every step the cost of that part of the process in labor, materials, tools, wear and tear, interest on capital, etc., and by familiarizing them with samples of schedules for keeping tally, and account books for keeping the costs, they become thoroughly familiarized with the idea that a process is good or bad according as the balance is on the right or wrong side of the ledger, no matter how tempting it may look on paper. They thus learn that an engineer who neglects to know how and when he is gaining or losing money is to be blamed. In order to still further keep the commercial bearing before them, as well as the theoretical, and to teach them how to distinguish between the right and wrong side of the ledger, they are required before they graduate to execute a project which is given them in a strictly commercial sense, and which they must execute in both a theoretical and a commercial manner, by giving the theoretical reasons for its adoption, and estimates giving the cost in detail not only of the constructions, machines, etc., but of every step of the work in detail. It is a very rare thing that such a project worked out by a student can be executed, but this is not the design. The object is to keep them familiar in every stage with the fact that no work can be done, no time or labor employed, and no material used, without involving capital and the interest upon it, wear and tear of machinery and

tools, and that they are, therefore, to look upon the scientific exposition of their profession not as a mere matter of theory alone, but as the combination of both theory and practice, which requires the scientific union of both, which can only be had in men educated in this way. Men so trained, brought into metallurgical works, have proved themselves to be worth a salary as they enter, and have shown themselves capable of rising in their profession with a minimum amount of cost to their employers.

In this age every man expects and is expected to make money. Every young man commencing has always in view a fortune, more or less large, amassed in a time more or less short. The first question of the father when he chooses an employment for his son, or his son selects one for himself, is, Will this or that profession enable him to become a rich man? No man expects to be one of the thousands of the unsuccessful, yet there are times in life, and there are commercial conditions, when losses are inevitable, and by making these losses an object of thought, and keeping them in the minds of young men, teaching them that certain processes and principles, if placed in practice under certain conditions, must inevitably bring about a loss when under different conditions they might yield a profit, I think we shall have accomplished an important point, by familiarizing men with the idea of loss. If the incipient engineer is taught that there are times, like the present, for instance, when the dominant question is, not how much profit we can make, but how little loss, we shall get rid to some extent of this idea of gain, and add an impediment to the idea being received that the generality of mankind can make money by other means than by working for it, and not always then.

The graduate must also enter the profession thoroughly convinced that he is not an engineer, though he may have the title, but that he has in his education the means of becoming one.

Above all things his education should teach the young engineer that honesty is not only the best policy, but an absolutely indispensable criterion to success. Every young man gains his experience more or less at the expense of his employer. What is produced is in his charge. It represents in a great many cases, besides the capital engaged in it, the wear and tear of human life. If he is strictly honest with himself he will understand that upon his endeavors are based the happiness and prosperity, and in some cases even the lives, of many a family, and often the interests and fortunes of his employers. It requires in a great many cases more

than ordinary courage to say he does not know the answer to a question, but will study it, and not try to improvise, when he should say that he requires to study. It is one of the mistakes of both employers and engineers to think that, because a man has a diploma, he must therefore be an encyclopedia, and the anomaly of the thing is, that this knowledge is demanded only of young men just entering the profession. No man would ask a distinguished engineer long in practice to solve a difficult problem on the spur of the moment. The engineer needs time to study and consider, and the employer demands that he shall take that time, but although in the case of the student the same interests are not involved in so great a degree, they are in a less, and the rule in a great many cases is not made to apply, but the young men are asked and expected to answer questions at once which can only be answered conscientiously after a more or less long study.

Every man who is an earnest worker makes mistakes. The man who makes no mistakes is free from them because he does no work. The wise engineer will always endeavor to find out what these mistakes are, and correct them before they have done any harm.

There can be no doubt that theory and practice should go hand in hand. It seems to me, judging from my own experience, and that of a large number of engineers, both in this country and abroad, with whose experience I am familiar, that the practical course, which we all consider to be absolutely indispensable, should follow the theory, that while the theory is being acquired, the student should see, as far as possible, the processes or machines which are being described, and the theory of which he is learning developed in practice, so that he may have some idea of what the process or machine is, without perhaps being familiar with it in all its details, then when the theoretical knowledge and the power to think correctly has been acquired, the practical course should commence. I do not understand by this practical course that the student should undertake, or should be expected to undertake, the work of a full shift. Very few students have the physique to do it, but they can work a turn, or a part of a turn, a phase, or a part of a phase, of an operation or process, so that with three or two, or perhaps no hours at all of manual labor a day, they may in a time more or less short become perfectly familiar with what they have learned theoretically. If there is not sufficient physique, a great deal can be accomplished by watching the workmen, and hearing them discuss, and learning to sift what is really good from what is useless in their conversation.

More is often learned in this way by observation than by actual work, and though there is no doubt a great influence to be gained over him by the muscular power of doing all that the workman does, and in setting him right when he exerts that power to bad advantage, it is doubtful whether the result is really worth the time which the young engineer must take to achieve it. We should not lose sight of the fact that what is needed in this case is not brute force to work, but the acquisition of a correct judgment, which is gained mostly by ear and eye education. Theory, without this ear, eye, and perhaps hand practice, except in cases of real genius, can never be expected to produce good results, and practice without theory is very much like endeavoring to do good work with poor tools. An artist can do it, and none but an artist can, but the world at large cannot depend upon artists, for genius is apt to be erratic and unpractical, and while it is undoubtedly true that the larger part of the workmen who execute the very intricate and elaborate practice of our best engineering and metallurgical works have very little idea of the theory of the process upon which their practice is based, it is also true that many of them have become practical artists, and have almost made their trade a profession, but they have taken years to learn by routine what an educated man will acquire in a short time. No one knows better than a man of education that he cannot always believe what he sees. He has learned it in physics, from the phenomena of persistent vision, and no one knows better than he does that he must learn to distinguish between what really is and what he thinks he sees, while an uneducated man thinks that if he cannot believe his eyes there is nothing to be believed.

There is a phase of technical education which I have never seen carried out anywhere except in Krupp's works, but which I believe to be practiced in some of the large works of France, and which applies only to those works where there are a large number of engineers associated together. At these works a council of all the engineers of the establishment under the president, Mr. Krupp, is held at stated times. The problems to be worked out are there discussed, and the executive officers for their solution appointed. Besides this the younger members of the corps meet frequently to discuss problems. Whenever anything new comes up which requires experiment, a certain amount of funds is devoted to that purpose by the works, and the experiments are made under the immediate supervision of those whose business it is to carry them out, but with the

active co-operation of all the engineers of the works. It is not wonderful that with such a technical school as this, established in the works, the works themselves and their proprietors have achieved such a reputation. I consider this establishment a permanent and irrefutable argument against the opposition of owners of works in general to allow young men to take practical courses in their works. We have besides in our own midst another answer to it, which is the general practice of the Bessemer steel works of this country. I am quite certain that but for this wise policy the American Bessemer plant could never have increased its product to such an extraordinary extent. I can understand perfectly that owners of works should object, and I should object as well as they, to young men standing idle round the works, often in the way of the workmen, asking questions that cannot be answered, or that would require long study to answer, with no intention of making any use of it except to perhaps retail the information at secondhand; but this is not the case we have in view.

One of the objects of this discussion is to ascertain whether in the minds of experts a practical course before or after graduation is desirable, and whether in the interests of the owners of works it is practicable. My own opinion, based upon nearly twenty years' experience, is that it is more desirable afterwards, and that it is really the interest of the works to have such a course carried on; but carried on in such a way that the young men shall study, and be required to show some fruits of their study, instead of being allowed to go around in the works at their will, and ply the engineers or workmen with questions. Such a practical course as this could be carried on with no trouble to the works under the supervision of the engineers, and I can readily conceive might become a source of real pleasure to the engineers in charge, and of profit to the works, for no student not anxious to learn would ever think of undergoing such fatigue and labor as would be necessary to gain the information sought. The engineer in charge would be surrounded by young men eager to learn, and ready to attempt the solution of any problem presented. The only inconvenience I can conceive would be that the engineers in charge of the young men, would be obliged to be extra-cautious in advancing theories or in making statements. It is certain that such a system, if adopted, would very soon train a class of engineers which are not now to be had, except in some few rare instances, like that of our honored President, who, by practice, has become so familiar with his profession as to feel in his own body when anything was wrong, or likely to be wrong. I

am quite certain that if the managers of works can be brought to see how much for their interest it is to have educated young men, eager to learn, around their works, we should soon have upon the stage a class of engineers who would, by careful study of theory and practice, in the course of a short time suggest such changes as would not only diminish the cost of production, but increase the product. If such places were made the reward for high attainments in the technical schools, and were coupled with a system resembling that of the English university fellowship, we should soon have young men studying in the works at home and abroad, all those intricate problems which the necessities of the case force individual countries to develop. It would not be a great many years before the reflex action of such study would be felt by the manufacturers themselves. There is a groping more or less in the dark for such a system in literature, and to a very limited extent in science, in some of our colleges; but it fails of any great influence because as yet it is aimless, beyond the attainment of a certain amount of information, and because the privileges of the provision last too short a time. I have been endeavoring to introduce it into professional engineering for some years with great success, but without much financial support. Some few able young men of wealthy parents have followed it under my direction most successfully, but no system can be regarded as a real benefit where the application of it is based on the accident of wealth. We need endowed positions like the fellowships in the English universities, which will allow the student who has won the position to pursue, either at home or abroad, a system of post-graduate study of those branches which the circumstances of the case has made specialties in certain countries, or to undertake under competent direction, investigations which require time, and which could not ordinarily be undertaken except under some such conditions. There are multitudes of such investigations in the profession which are waiting, because the necessity of making them *now* is not apparent to the manufacturer, or because no one works could undertake the expense. In support of the proposition I can point not only to what the English fellowship system has done for literature, theology, and philosophy, but also to what the Swedish iron comptoir has done for metallurgical science, not only for Sweden but for the world. It is very doubtful whether but for this institution the Bessemer and many other processes would not have been declared failures. It has supported and maintained investigation, theoretical and practical,

which never could have been commenced but for the intelligent foresight of the managers of that body.

In this country it could not be expected that any such endowment as that of the Swedish institution could be accumulated in a short time, but our technical schools might easily establish a post-graduate fellowship system, and it would not be very long under this influence before we should cease to hear of what cannot be done, and regard every question as a problem to be solved, with, for the time being, a plus or minus sign, which is susceptible of change under varying commercial conditions.

MR. ROBERT W. HUNT, *Member of the American Institute of Mining Engineers.*

MR. CHAIRMAN: As has been observed by so many of the gentlemen who have preceded me, there has been a striking unanimity of opinion as to the necessity of a good general culture, as well as a practical education. All have seemed to agree on these two points. The only difference of opinion so far in this discussion, as I understand it, is as to *when* that practical education should be obtained.

I think we are all governed in our judgments by personal experience, and it is, perhaps, for this reason that I have a strong predilection for placing the practical education before the thoroughly scientific one. Granting decidedly that, first of all, general culture is very necessary, I believe that, so far as metallurgical engineering is concerned, after the general culture should come the practical, then the purely technical education. I cannot judge for the other branches of the profession; I only speak of that of which I have some knowledge, and in which I have obtained some experience. I spent some four or five years in practical iron manufacture before entering the laboratory for a technical course, and the practical knowledge thereby acquired gave me a standing in advance of other students. I knew what it was that I was seeking to investigate, and it seemed to me that I arrived at some points quicker than other young gentlemen around me who were possessed of larger natural ability. When it devolved upon me to assume active duties and responsibilities, I certainly was better qualified than if my ideas had first been moulded by theory.

I agree with Prof. Egleston, that a boy cannot be expected to work as hard and produce the same results as a person of mature years—"cannot be expected to work a full shift in any branch of labor." It would be wrong for him to try to do so, for were he to exert him-

self to the full extent of his physical powers, his mind would not be in a state to investigate the theory of what he had been doing.

But there is one point which we seem to be overlooking. *Where* is the student to find these practical schools, whether they come before or after the technical schools? I freely confess that, as a rule, proprietors of manufacturing establishments do not like to have students in their works. While I believe this to be a mistake in other branches, I know it is a mistake so far as Bessemer works are concerned. If the plan suggested during the first discussion of this subject is to be carried out, that is, if the students are placed in charge of a competent teacher, who is responsible to the manager of the works, the establishment will be benefited. Owners will, I think, soon begin to realize this, and thus schools will be furnished. I hold that, as the student will report to his teacher what he sees and hears, coming to him for explanation; and that, as the teacher reports to the manager, the works will have just that many more overseers. The workmen will realize this, and so fewer departures from the desired practice will occur. The teacher will fully understand the policy of the management. He will, so far as necessary, explain this to his pupils, as well as the details of the works. While working with the men, students will observe all that occurs, and will ask and answer questions, and, while they act as a kind of moral check on the men, the men will be induced to think, and as soon as a man gets to thinking he is started in the right direction. Then, on the other hand, while the student is learning how to use his own hands, he also learns how much one pair of hands can do, thus laying one of the strongest foundations of success as a manager, viz., an accurate knowledge of how much to expect from labor; and his own physical man will be developed far better than by boating or other such exercises.

If this practical study is left until after the young man finishes his technical course, the danger is that neither he nor his parents will be willing in most cases that further time shall be spent on his education. The feeling will be, "Oh, the practice will come." So it will, but at whose expense? And it will not come in time to guide his theoretical studies.

No manufacturing process has made such wonderful progress as the Bessemer, and its gigantic strides in this country have come from breaking loose from old practices. This result has been to a large extent brought about by introducing educated men into the works, thereby creating an atmosphere of progress, a willingness and ability

to get out of the old ruts. They are men who possess, beside a general knowledge of metallurgy, a thorough knowledge of the special branch; and they also have around them intelligent workmen.

I will cite the case of one Bessemer works, the one that is now turning out the largest product in the world. Their manager is a graduate of the Rensselaer Polytechnic Institute. Before assuming any responsibilities after his graduation, he entered upon a regular routine of work of some years' duration at the Troy Steel Works. After this experience he entered upon the management of the works with which he is now connected, and his career has been singularly successful. I doubt if this result would have been reached if he had taken a department even, of the management, immediately upon leaving the scientific school, as so many graduates have attempted or desired to do. So, while preferring that the practical course should precede graduation, we find good results from the other plan. As to the importance of both the practical and the theoretical education before the student ventures to practice, we all seem to agree.

PROF. C. O. THOMPSON, *Member of the American Institute of Mining Engineers.*

MR. PRESIDENT: I deem it a considerable privilege that the first time I have the honor of addressing the members of this Institute, the subject should be Education. For many years it has seemed to me that the future of all the industrial arts is conditioned upon the careful and philosophical unfolding of a system of technical education. What little I may contribute to this discussion, which has been so ably maintained, shall be to this precise point. And perhaps it will be useful to relate as briefly as possible, the results of an eight years' experiment in technical education in the city of Worcester, Massachusetts. In this school the different ideas which have been broached during this meeting have been subjected to a practical test, and a recital of the results will accord with the spirit of this discussion.

It is somewhat natural that a school of technology should be established in the county of Worcester. More than two hundred years ago the first school of this sort in England was founded by the Marquis of old Worcester. The population of its modern namesake is one-half of one per cent. of the population of the United States, while one per cent. of *all inventions* made in the United States is accredited to citizens of this county.

It is an interesting fact also, that a citizen of Massachusetts, Dr. Bigelow, is entitled to the honor of introducing the word *technology;*

at least no earlier reference to its use is made in Worcester's Dictionary. Indeed the geographical position of Massachusetts, and her dependence upon the prosperity of her varied arts and industries, renders technology, in its broader and its narrower import, a subject of great interest to her citizens.

Eight years ago I began to study this subject and to incorporate the results in an actual course of training for boys who are to be engineers. In organizing this school we had little light to steer by. All experiments hitherto made in this country, at least to combine manual labor in any form, have not been largely successful. Hence we have been compelled to move very slowly.

The Free Institute was founded by John Boynton, of Templeton, a tinsmith, who desired that apprentices in the mechanic arts should have a more intelligent preparation for their business. This endowment was largely increased by Stephen Salisbury, of Worcester, a Harvard alumnus, who desired that theory and practice should go hand in hand, and by Ichabod Washburn, founder of the Washburn and Moen Manufacturing Company, who merged in this scheme a cherished plan of his own for the education of mechanics' apprentices. Citizens of Worcester contributed money for the buildings and the State made a grant of $50,000. The whole amount of the plant is $600,000; the available annual income $25,000. The school is free to Worcester County, substantially so to the State of Massachusetts, and open to all qualified applicants.

The theory of the Institute is that boys who have the best training afforded by our common schools may enter, not younger than sixteen, upon a course of study which shall give them a good education based upon the mathematics, modern languages, and physical sciences, and such a knowledge of some form of handicraft or industrial art as will enable them to earn a livelihood immediately after graduating. The conditions of admission are fixed by the actual results of common school instruction rather than upon what ought to be expected of it. For instance, we find few boys who really understand algebra well enough to use it as an instrument of research. Many have been "through it," as the phrase is, but hesitate before such problems as, given $\frac{a^n - b^n}{a - b}$, required to show that a perfect division is possible, or given $t = \frac{a}{m - n}$, required to show the significance of each possible value of t, and how its value is affected by changes in the other term. We find that the only sure and safe way

is to teach algebra from the beginning. A knowledge of arithmetic, geography, history, and English grammar we take for granted after examination. The course of study for all students then proceeds, for forty-two weeks in a year, for three years, in mathematics, through geometry, general and descriptive geometry, and the calculus, and blends with the course in physics and elementary mechanics, the careful reading of Rankine's *Applied Mechanics*. Synchronous with this is a course of free-hand drawing, mechanical drawing, physics and chemistry, and language—the English and either French or German. Lectures in geology are given, and the course in chemistry includes determinative mineralogy. So much is taught to every student in a three years' course.

Now ten hours a week, and eight hours a day for the month of July, each student practices according as he is to be a mechanic, a civil engineer, a chemist, or a designer in the workshop, the field, the laboratory or the drawing-room. But since the last named forms of practice do not differ essentially from the same work elsewhere, I will confine my remarks to the first.

The Washburn machine shop, part of the Institute, is a thoroughly equipped manufacturing establishment. Boys who have had no mechanical training enter it in February and spend most of their time there as apprentices till July, so that our mechanics' course is a half year longer than the others, for absolute beginners. There are five principles embodied in this shop:

1. *Construction* must vitalize and guide all *Instruction* in practical mechanism. If a boy turns a wooden rod it must form part of some structure, and if not found good enough, must be reproduced till it is good enough. Whenever two pieces of wood or of iron are joined, the resulting piece must be subjected to the absolute test of accuracy which is imposed by the highest standards of manufactures. In this particular our plan differs from that of the admirable schools at Moscow and St. Petersburg, where separate attention is paid to construction; but for American boys I am sure there is good reason for us to adhere, for the present at least, to the synthetic method. I was unable to get access to these Russian schools in 1868, when examining European methods, and could take advantage of their interesting results only at the Vienna Exposition. Hence the methods are fairly and simultaneously under experiment.

2. Practice must form a part of every week's work, in two periods of five hours each.

3. Students must be taught by the most expert mechanics, and

use the best possible tools and machinery. Nothing is too good for a boy.

4. Students must not expect nor receive any immediate pecuniary return for their work. It is impossible that the best men shall be employed as instructors, the best machinery made and used, all subjected to business conditions, and a large number of apprentices taught in small divisions, with any other return to the student than the advantage of learning.

5. Since instruction and not construction is the main motive, each student is advanced in the grade and quality of his work as fast as his attainment permits.

The shop is thoroughly equipped with tools and machinery for working wood and iron. The apprentices, that is, those who enter in February, work wholly in the wood-room during shop hours, and have training in drawing ten hours a week. From the beginning of the junior year the students practice in the iron-room, learn the management of the engine, and make working drawings of machines for use in the shop. We often receive at the beginning of junior years young men who have already worked in a machine-shop one, two, and even six years. These students are always numerous enough to enable us to compare the relative advantage to a student of preliminary shop practice.

The shop is under the direction of a superintendent, a graduate of the Chandler school, with six years of shop practice behind it, and two foremen, one in wood work and one in iron. The force of journeymen varies from six to twenty according to the condition of business. Certain standard machinists' tools are manufactured, viz.: An engine lathe (described by Prof. Thurston in Johnson's *Cyclopedia*, vol. 2, Art. Lathe), a speed lathe and an emery grinder. We also make a draughtsman's stand and sets of models used in teaching drawing. These we have brought here to the Exhibition and offer for examination in Machinery Hall, in order that you may see that this Institute is not a school with a shop attachment. We wish to find out in this most desirable and satisfying way, whether we are really giving our students the best models of workmanship, and illustrating the best American practice. I may also say here that the whole scheme and plan of the Free Institute are on exhibition in the east gallery of the Main Building, and the valuable examination and criticism of the members of these Institutes of Engineers are much desired.

To return a moment to the shop. It must be stated that in addi-

tion to its standard manufactures, contract work is done, such as the erection of hydraulic elevators, etc., with the intent to give increased variety to the work. Some of the more palpable difficulties in the business management of the shop are met by considering that the whole plant is a gift and free from taxation; that the early work of beginners does not involve a great waste of stock, and that, although students enjoy the advantage of doing all kinds of work which are done in the shop, whatever is actually *sold* must satisfy a rigid standard of excellence. I suppose we sell about $18,000 worth annually. The profit on these sales together with the income of the shop endowment fund of $50,000, enables us to meet all expenses. Or, if the total annual expenditure in the shop be divided by the number of students who work in it, the per capita is about $120 a year.

Now, I hope I have sufficiently emphasized the point that everything a boy makes in our shop is done with reference to some use. He does not make joints merely as such, or file away a piece of iron merely to learn the use of the file. He learns to make neat joints, but they are parts of a box or of a model. He learns to file, but the piece he files must fit into its place in the machine. So we try to make construction direct, and to temper and strengthen instruction. There is a certain proper and logical order of parts in the training of a mechanic, and this is not lost sight of. In short, the graduate of our school, with the practice I have outlined, we believe to be able to hold his own in open competition with the apprentice who has worked, under ordinary circumstances of apprenticeships, three full years; experience so far confirms this view. Here, as always when speaking of results, I desire to speak with great diffidence. The results are those of six classes and eight years. They are alluded to as grounds of our willingness to proceed with further experiments in the same direction.

Mr. President, I have gone on in this rambling way talking of *our* work, and I fear the story is wearisome. [Cries of, "Go on."] It seems to me that there are three elements in all sound technological training,—handicraft, technical training, and culture. There has been a surprising and gratifying unanimity of opinion on this point among the gentlemen who have spoken. The only question is how these elements shall be combined.

What is the object of technological schools? It is to produce the best possible raw material for skilled workmen. No school can

impart the skill and good judgment which come alone from experience, and without which no man is a competent engineer.

Another question with which a school has little to do is whether a youth shall be a superintendent or not. I take it that the Almighty makes superintendents. The precise kind of talent which enter into their characters is strictly an endowment.

In this discussion some have held that the order should be handicraft, technics, culture; others culture, technics, handicraft; and others would arrange in other ways. But there is one objection to all these sandwiching methods. Practically we cannot hold our young men in training till twenty-five. They will go at twenty-one or twenty-two. The period of sharp acquisitiveness, the most precious part of school life, lies between sixteen and twenty-one. Now, whichever part of a boy's triune discipline for an engineering life is allowed to usurp that period to the exclusion of the others, that will be the dominant force in his after-life. If culture, then practice will suffer; if practice, culture will suffer. Either part will be, as it were, attached to, or subordinated to, the one which "rules the favored hour." Hence it seems to me that all possible culture should be secured before a student begins his technological course, and that it should be looked to ever after. It must not be forgotten that culture is a result, or rather a growth. All we can do is to prepare the soil. The plant will assuredly grow. Perhaps, too, the best and only useful culture is to be looked for in the life for which any school training prepares a man; for I take it, we are not now speaking merely of the cultivation of the æsthetic part of man, but of that discipline of the judgment, awakening of the imagination, sharpening of perception, repression of conceit, and elevation of motive, which constitute a serviceable and efficient man of refined taste and unquestionable integrity and courage.

Let us secure as large a foundation as possible in general knowledge before the beginning of the technical course, and not lose sight of the bearing and relations of all knowledge during this course. But let us blend technics and handicraft in the technological course. The drift of this discussion has been unmistakably towards the affirmation that the technologist of the future is to be the educated workman. It is to the man whose own hands can execute, if need be, the behests of his brain, that the great engineering works of the future are to be intrusted. Engineering, so happily defined by the retiring President as "the arts of production and construction," including mechanical, civil, mining, and chemical branches, more and

more condenses into mechanics. Indeed, all branches of engineering seem to react upon mechanics, forming compounds like different acids upon a common base. We are coming to think that, if a man is to be a civil engineer, he had better begin by being a mechanic. If he is to be a mining engineer, he had better begin by being a mechanic. If he is to be a chemical engineer, he had better begin by being a mechanic. This is true, at least, of all study of *applied science.*

Now, as to the amount of preliminary culture, it is desirable that at least what is included in fitting for college should be secured. I do not think graduates of college in general will be drawn to technical pursuits. The whole drift of the college is averse to them. Few boys are so powerfully polarized as the sons of the honored member who spoke last evening. What might be very easy for Mr. Sellers would be very difficult for a father in other walks. In short, it seems to be the best available method for the average boy to fit him for college, then send him through a technical course in which handicraft shall find a place; then let him enter some manufacturing or engineering works, and see what it all means.

There are a few other points in the course at Worcester which I will mention, as throwing light upon some parts of this discussion. Whoever takes pains to read the examination papers, and consult the returns on them in the Exhibition, will see that the standard of scholarship is not suffered to fall. It is no part of our plan that the workshop instruction shall invade the province of intellectual preparation for an active life. If our graduates suffer in consequence of any lack in the *essentials* of an engineer's training, the fact has not come to our knowledge. The exhibit in the east gallery is designed to show that the Institute is not a shop with a school attachment.

The graduate receives the *degree* of Bachelor of Science in course. This is a short way of saying that he has had a mark of at least 60 at each semi-annual examination, and has completed the course. Then we offer a degree which shall recognize professional success, to every graduate who in actual life achieves that success.

By the blending of school and handicraft we secure an equality of social regard, which is a matter of great importance. There is no chance for the scholar to discriminate against the workman, nor for the reverse. There has never been any caste feeling in the Institute.

The only electives are courses rather than studies. A boy may elect his course, but cannot elect his studies. We deem it to be

wholly for the youth's advantage that men who have experience and knowledge should devise the means and method of his training, rather than these should be remanded to his own unenlightened tastes.

What the graduates have done will be seen by examining the catalogue. Some teach, some become draughtsmen; many become journeymen. The chief peril they encounter lies in the temptation to devote themselves to earning the immediate dollar rather than the remoter fortune. Many a good man has been drawn into the office as a draughtsman, from the bench, where a true conception of his own highest interest would have kept him. But all these difficulties time will remove. Success somewhere ought to be assured to graduates in the act of graduation, provided always success is sought with clean hands and a pure heart; but success in becoming superintendents and foremen cannot be insured. Many a youth errs greatly in fixing his eyes upon this as the only success, forgetting that it is not *what* a man does, but *how* he does his work, that is the *crux* of a successful life.

It seems to me that this question of technical education is of sufficiently serious import to warrant the attention given to it by this body of engineers. Educators will read and ponder your remarks and suggestions with extraordinary interest; one of them, at least, with gratitude, for it is a matter of no ordinary moment to take into one's hands an intelligent, enthusiastic youth, and to so direct as to practically control his future.

THE CHAIRMAN: We have but a little time before we must adjourn, and you will regret with me that the discussion which has become more and more interesting, will have to close so soon.

Out of a number of gentlemen who agreed to take part in our proceedings, some were absent last night, or their names would have been called; and some are still absent. Several have furnished in writing the remarks which they would have made, and I earnestly hope that those gentlemen who are obliged to leave to-day, before they get opportunity to speak, will take the same course. It is the intention of the joint committee to publish these proceedings.

Every gentleman who takes a part in this discussion will have the opportunity to revise his remarks before final publication. Those who for any reason do not speak, are requested to send to Mr. Holley, the secretary of the committee, their views written out for publication.

MR. P. H. DUDLEY, *Member of the Institute of Mining Engineers.*

MR. CHAIRMAN: Having been asked to discuss this subject with reference to railway engineering, I shall assume it to be granted that thorough technical culture and training are necessary in all departments of this branch of industry, and I shall consider the question—how and when can such education be best imparted?

Technical education implies in its fullest sense a thorough knowledge of scientific principles, and their application in practice. In the question under consideration, by what is really a misunderstanding, we are apt to consider, especially in our youthful days, the two great means of education, viz., our schools and the railways themselves, as having a repulsion instead of an attractive affinity, whereas, in fact, the practice of the railways is but the higher development of the school,—the utilization of the principles taught in the school; so that the want of harmony between them is more imaginary than real. Railway work has such a broad and comprehensive meaning that it includes in its detail more or less of all the distinctive departments of engineering; also, general science, law, finance, and not least, a knowledge of the condition of the people. It is a recognized fact, that the men who have the best understanding of all these, and the nerve and ability to execute, are the most successful railway managers. It is true that railway work is conducted under separate departments, yet the man in general control should have such a technical knowledge of the respective details that he can detect an error in administration, and give general directions for its correction. I need not tell you that this knowledge of details, and ability to execute, can only be acquired by practice; it cannot possibly be acquired from theory alone.

Our limited time of ten minutes will not permit us to go into the details of all the departments of railway work, yet from a few explanations it will be readily seen that some branches of the necessary education can be more easily imparted in the school than others—from the fact that it is within their scope to combine the theory with the practice—such as chemical analysis, testing the strength of small materials, etc. But when we come to the erection of great structures, preparing the foundations, executing engineering works, and conducting their operations, we pass away beyond the scope and ability of any school to furnish the means for such *experience* as the engineer must have. No matter how well he may be versed in theory, his faculties must be so well trained by the discipline of experience that in an emergency he can intelligently and calmly command him-

self and others. No matter how well the plans may be prepared for a particular foundation, something often occurs entirely unexpected, requiring quick and decisive action, which is only possible to the practical man. It is in theory very simple to make a reconnaissance for a railway, but it takes long practice and education of the eye to enable one to judge correctly of the many lines before him, retaining their features in his mind so that he can recall and pass them in review for comparison with other lines.

In construction one can acquire in theory but a small part of the knowledge which is necessary for successful practice. Timber and other material is not usually found the same as described in books, yet the best effect must be produced which the circumstances allow. The faculties must be so educated by long familiarity that one can take in the situation at once, and decide upon the fitness of his material by intuition as it were, and not be obliged to spend days to test every unimportant piece of his structure.

In public works, the frequent want of honor, on the part of persons connected therewith, increases the difficulties of construction to an alarming extent, requiring much practical experience to judge of the quality of work and to oppose the guiles and flatteries of those who are interested therein. Questions are constantly arising which were not even treated in books—the solution of which not only involves principles of construction, but those of honor and reputation, requiring the engineer to act as an impartial judge between parties. Is it to be expected that men will be put in charge of such works without experience in such matters? In railway operations especially, those who conduct them must have experience—must be so trained and disciplined in the very work they are doing that they are masters of the situation. Accidents from the elements and from human weakness, carelessness, ignorance, stubbornness, and malice are liable to occur at any moment. In view of all these constant dangers to life and property, railway managers feel their responsibility, and they do not call men to fill such places until they have been tried and tested, in the progressive school of experience and practice, and found not wanting.

Besides knowing the principles from a study of theory, it is necessary to educate the faculties, so that impressions will be distinctly seen and properly comprehended. There must be such broadness of view that superficial conclusions may be avoided. One must have such training as will correct the ordinary aberrations of unskilled sight; the touch must have its sensibilities increased, the ear must be

trained—in short, all the faculties must be on the alert to properly direct engineering work. This can only be acquired by practice and experience, the length of time depending upon the ability of the subject.

It is a delusion to hold up to young men the idea that, as soon as they have completed their theoretical education, and become conversant with the principles of science, they will be called to places of responsibility. Such men are only partially educated.

On many railways they have a system of promotion, advancing men as they acquire experience to higher positions, but, in every instance, to manage departments with success, the man must have also the technical education, and if he has not acquired it in the humbler situation, the railway company will be taxed to pay for it. Take the car builder, for instance. If he does not know how to construct his cars with the least amount of friction, the companies pay for his want of knowledge in the increased cost of running his cars. If he increases the dead weight unnecessarily, the company pays for moving it, as well as the increased cost of construction. Take the master mechanic. If he has not brought his motive power up to its highest standard, the company pays for the want of his education in the increased cost of doing their business. If the civil engineer has not adopted the most judicious grades, and the shortest line, the company pays for his want of education in the increased cost of operating their road. It does not matter what officer it may be, if he does not recognize and follow out correct principles, some one must pay for his want of education. Principles of science are not invented; they exist in conformity with unchangeable laws, and are not subject to the dictation of any man, however high in authority. It is true that art has preceded science in all cases, but its development is in the ratio of the knowledge and application of scientific principles.

It is less than half a century since our vast railway system was inaugurated, and from the constant improvements which are being daily made, no one presumes that it is near perfection, therefore we must not expect that the science has been fully elucidated, and its principles pointed out. The art was practiced long before any systematic inquiry was made into principles. To determine these requires the collection of facts pertaining to all the operations of conducting railways, and arranging and tabulating the results. Now, while a vast amount of information can be obtained, much that is needed is not even kept by railway companies, and what is

kept is merely approximate, from which correct conclusions cannot be drawn. If railway companies, who have the facilities for collecting correct data, so as to profit in the greatest degree by their own experience, fail to do so, is it just to expect that our schools, without facilities, can collect this data, and formulate the results for railway men? One great reason why theories of railway operations oftentimes prove so futile, is, that the conclusions were formed simply from a mass of error furnished by the railway men. Are the school men responsible for this? To educate men who are to control railway affairs, it is clearly the province of the schools to furnish them such a training that they may know how to think upon a broad, theoretical basis. The schools must develop the powers of thought so that principles can be recognized, and a still higher discipline will show how to discover principles. It is clearly the province of the railways to teach adaptation and utilization.

The same considerations are equally true in regard to the subordinate men who form a part, as it were, of our railways. It is only within a few years that any theoretical education was considered necessary for the ordinary railway man, but now that it is, employés, encouraged to some extent, have formed organizations to assist themselves in gaining the theoretical knowledge. Railway companies to some extent give premiums for the most efficient services, and find that such investments pay well.

We must not underrate the great and noble work our schools have accomplished in liberalizing thought and advancing civilization, and in thus indirectly promoting the development of engineering. It is only important for teachers and students to remember that the graduate is but half educated, and it is equally important for all the workers, however high or low their position, to remember that but half the elements of professional progress can be derived from unaided practice.

PROF. J. B. DAVIS, *Junior of the American Society of Civil Engineers.*

MR. CHAIRMAN: It is with great diffidence that I rise here, a mere boy, to speak to this audience. Those who have preceded me have anticipated already what I had intended to say. I must beg leave to call your attention more to my manner of looking into the subject, than to anything new I may present that bears upon it.

It seems to me that we labor under difficulties, in the matter of technical education, precisely similar to those that are of a funda-

mental character in education in the schools in general. We are in danger of doing, indeed, we have been doing, the same things that are and have ever been done by educators since schools were. There has been a world-wide attempt for centuries, to substitute the training of the intellect for the complete training of the whole individual. Let us for a moment consider how many there are of the millions that throng the earth, that, being called upon in the daily affairs of life to take action upon any matter, will act from previous intellectual training. Certain it is that their training in this respect does assist many in forming their opinions or in conducting their operations, but this is only an item in the great mass of activity. Consider the myriads of *little* deeds, if I may call them so, that go to fill up the sum of the work of each one of us, and to really make our lives what they are. Does intellectual training furnish the mainspring of effort here? Certainly not. We do what seems to us to be best at the moment, according to the way in which we are affected emotionally, and not intellectually. I think we may well ask this broad question concerning all our usual schooling: Is the most necessary part of our education attended to? If we do not usually act from the motives furnished by our intellectual training, are we wise to devote our whole energies to the training of this kind, to the almost total neglect of that part of ourselves from which the real motives of action arise? There will be much said during this year of grand celebrations and general congratulations upon the completeness, worth, and high character of our well-nigh universal school system. I am one of those, too, who are ready to regard the results attained with great general satisfaction. There has been an immense and valuable work done, but it seems to me to be a matter of the greatest consequence and significance that so much has remained undone, even almost untouched.

Now, as regards technical education, for I cannot dwell longer on the interesting considerations hinted at above, we are doing in a measure a similar misapplied and defective work. Each one here knows of many instances in which young men ostensibly prepared for some department of practical life in the schools have failed partly or entirely owing to improper training. Indeed, the general expression of opinion here given has been one of distrust of a simply school-educated young engineer. Now what is the trouble, and wherein do we find the difficulty? The trouble is in seeking to make one kind of training answer for another, or in exclusively training one set of faculties when another should be trained. The difficulty lies in copy-

ing too closely the theories and methods of the schools in general. It is a well-established fact, that a technically educated person must possess judgment in the line of his work. This has been repeated and reiterated here. Who supposes that he will possess that judgment if he never has a chance to exercise it? If I stand over my boys and tell them here, do this, or here, do that, they will never be *judges* of their work. They must be set by themselves to execute plans alone. Another attribute of a good engineer, if I may refer to him as one of the technical class, and one which I have not heard as much as I wish about, is that of resources. He must be a man of resources, of invention, of ready expedients. Can a man hardly be an engineer at all without this invention? This thing has been incidentally referred to in many of the communications, but I wish to emphasize it. The engineer must be a man ready to act whenever he is called upon within his field, in all emergencies, and on all occasions. The young men are to fit themselves for emergencies, for ready, reliable action on short notice, or under difficult conditions. Who supposes for a moment that a man will possess resources without ever having faced a difficulty? These two illustrations indicate in a way, the nature of my theory of the training a technical man should have, which is this: Consider well what characteristics he should possess, and then seek to develop them in him if he has the basis. If not, tell him so, and not prepare him for the great disappointment of losing his years of study and work in a great failure. As to how this result is to be reached, I will say this: At the University of Michigan we have met the difficulties alluded to, that is, a disposition to follow old methods and theories of intellectual training. It was supposed that an engineer must be well developed intellectually in certain directions. Therefore certain studies of the older courses were retained and advanced, and others added to give him what was deemed a desirable power in these directions. Much was done of a *practical* kind, so called. For years they have been feeling their way along at this institution, seeking by thought and experiment what was best. And in my own experience I will say that I have been satisfied with the result of my teaching about in proportion as I was able to realize the conditions of actual practice in my instruction. Personally, I think the same is true of the whole work of the engineering department, except I will add that these conditions were supplemented by good class-room instruction in theory. And as to the manner of combining theory and practice, I have but this to say, although much has been

said upon this head; I think the more intimately they are combined daily, the better.

As to mathematics, which have been mentioned, we think, at this school, that there is such a thing as enough mathematics for civil engineering students. The conclusion has been reached that there is a point where the course in these studies should stop. Perhaps our conditions are somewhat different from those of the gentlemen who have preceded me. A certain amount of mathematics well mastered is what we desire. A limit has been reached with us for our undergraduates.

I would like to say a few words about the study of drawing. Instruction in drawing should not be postponed, as is frequently the case, till the student enters college. It should not begin in the high-school, nor even in the grammar-school, for this reason: it is, crudely, to be sure, a more natural mode of expression than writing or even talking, yet this method is left to be taught long after these others have been acquired. But I shall be told that the others are absolutely necessary in the common affairs of life, and must be learned. True, yet how many educators have considered the relations and mutual helps which exist amongst the different methods? The absolute "bread and butter" importance of drawing is just being felt and realized. It is a matter of common occurrence to see two persons conversing, and what one cannot make clear to the other by words he will seek to mark out, it may be with a stick in the dirt. How readily do we all seek this method of expression. Much more can be said about its natural relation to us. It certainly seems that the child should begin drawing soon after learning to read easy words. The Kindergarteners begin it really before this.

As to the young men having command of their knowledge, which the gentleman from Worcester referred to. When the engineering students reach their junior year with us, it happens that I teach some little things then calculated to open their eyes to the fact that there is quite a difference between learning a thing well enough to make a recitation upon it, and mastering it so they can use it. Sometimes it takes the third trial to get a good recitation at this point in their course, and they generally have quite an experience during those three days. The lessons are long and the parts so similar that memorizing is a hopeless task. They must *master* the work in order to recite. The test applied at this institution to find out whether a man knows a thing is, can he do it? So far as possible this is

everywhere carried out. It is not enough that he can converse about it. Can he do it?

One word upon the item of integrity, and I am done. The only thing I will say is to relate a short anecdote. I once had an assistant whilst continuing some railroad work from previous surveys by another man. This assistant had been upon the work before I was, and had worked upon the preliminary lines. He was the leveller. I was locating over his preliminaries. As we worked along, a number of errors were detected in our levels. These kept accumulating. Upon investigation I found that this assistant, who was still running the level, had made an error of twenty feet upon his previous work. This he had nicely distributed through his notes, so that it did not at once appear. This was far away in the woods of Northern Michigan, where it was impossible to obtain a man for this kind of work. The way we prevented him from doing more mischief was to set the rodman to watch him. Each kept a separate set of complete notes. They were not allowed to show their notes to each other till the day's work was done. Then they were obliged to go through them all in the evening, and compare them carefully. In this way we fixed our leveller so as to keep him honest till we arrived where we could get rid of him. I think I tried hard enough to teach that man the error of his ways. Some years after, I received a letter, to my entire surprise, from my delinquent assistant. He was then a resident engineer in charge of 600 miles of line in Minnesota, and he said, "I owe to you, Mr. Davis, my position, because you taught me by your severe treatment," in the case referred to, "the value of integrity." He further said, "After I left you I went West, and went into an engineer's office as a draughtsman at a dollar and a half a day, and in these few years I have come to be in charge of 600 miles of line." Let the story carry its own moral.

MR. FREDERICK J. SLADE, *Member of the American Institute of Mining Engineers.*

MR. CHAIRMAN: If it were certain that all the young men who enter our technical schools had the natural qualifications necessary to be engineers, then the problem, of what the course in such schools should consist, would be materially simplified. But when we remember that it is impossible at the early age at which young men enter on such a course, to determine accurately the natural bent of their minds, the necessity of first imparting a liberal general educa-

tion is apparent, so that those unfit for engineering pursuits may have other fields opened to their view, and may be drawn away from a profession for which they have no fitness. I therefore agree with the remark that has already been made, that if it were necessary to choose between a strictly technical education and a more general course, the latter would be the more desirable.

I believe further, that not only is it desirable on account of the various types of mind to be found in a body of undeveloped young men, that education should be general rather than special, in order that none may be graduated without having received a training which shall be of service in his particular case, but that even were the classes composed of none but those qualified to become engineers, it would be much better that the instruction should be confined mainly to the theoretical part of the profession, leaving the practical details to be learned afterward, in that school of actual practice from which the engineer never graduates. I know that this would require some of our schools to give up some of the very things that they most pride themselves upon, yet I believe the effect in the end would be good.

I think it has very generally come within our experience, that those engineers who have received that very elaborate education in foreign schools, of which so much has been said, do not make the most rapid progress in the practice of their profession. The effect of their study seems to have been to give them a disproportionate confidence in the sufficiency of the formulæ and text-books of the school, to solve every problem that arises in practice, and the faculty of judgment so necessary as a check upon theoretical deductions becomes dwarfed by disuse. It sometimes seems even to be the case, that those who have received this training refuse to admit the necessity of correcting their theory by facts, and hence shut themselves out from the greatest of all schools.

It has been remarked with force by Prof. Thompson, that the acquisitive powers act with greatest vigor before the age of twenty; and he argues that on this account both theoretical and practical education should be crowded into this period. While it is no doubt true that the mind is at this age better able to receive scientific education, and to be moulded by it to correct methods of thought, it may be doubted whether the ability to weigh the value of practical expedients is as much a characteristic of a young as of a more experienced mind. It would, therefore, appear to be wiser that the period of life in which the mind is best adapted to receive that sci-

entific training which is to shape all its future action, should be devoted to the study of science, rather than wasted in the vain attempt to acquire an incomplete and delusive acquaintance with practice. One very important result of this would be, that the young graduate could not by any possibility imagine himself an engineer, and would thus be ready to commence at the bottom, and on a true foundation lay up in intelligence and order, that experience which is the capital of the engineer.

It may be asked, why should not the teaching of practice *with* theory have the same effect in establishing a proper balance as when acquired subsequently? To which it may perhaps be answered, that the conditions under which the practical matters are presented are in the two cases widely different. In the school they are presented as problems solved, in actual practice as problems to be solved; and the fact of the solution being at hand in the former case gives a false idea of complete mastery of the profession, the precise reverse of that modesty which is forced upon one, in the latter case, by the uncertainty whether he shall be able at all to reach a solution.

As to the proposition that the student should in the midst of his theoretical course, take up the study of practice as presented in the workshop, I think it is a question whether the time so spent would not be spent wastefully. It is indeed highly desirable that the young man while pursuing scientific studies, should be sufficiently familiar with at least the surface facts of practice to give life and meaning to the abstract truths which he is studying. But this acquaintance he can acquire in those afternoon visits which every young man, having a taste for engineering, is sure to make to such works as are within his reach (and in these days there are a multitude in all places), while he could acquire but little more by a constant attendance in the shop, *unless in actual employ and with a weight of responsibility resting upon him.* It is only when the sweat comes out over a man in those emergencies, when he knows that something must be done, and done quickly, that he begins to lay up valuable experience.

Now, it would be impracticable to provide such employment for students; and I think it may also be said that in nine cases out of ten, where it could be provided, the young man would never return to school, because the ties that would bind him to his actual work would be too strong to be severed.

In a word, then, let the schools give a liberal and scientific education; let the student give concrete form to abstract principles as he may from visits to such works as are within reach, and by the read-

ing of current engineering literature, and let the acquisition of practical knowledge begin and go on without interruption after the school course has ended.

MR. ASHBEL WELCH, *Member of the American Society of Civil Engineers.*

MR. CHAIRMAN: I move that the Joint Committee be requested to take into consideration how to put a stop to the practice of the technical schools giving the young men who have just graduated the title of civil engineers.

In the first part of my remarks last night I had this paragraph: "The young man that graduates from a technical school is no more a civil engineer than a young man who has never been at sea, but who has studied navigation at school, is a sailor." The same thing has been better expressed by Mr. Coxe, that a graduate is excellent raw material to make an engineer of, but he is not an engineer. Now you confer this title when these young men graduate, and what is the result? Why, they think that they are engineers, and the consequence is that in nine cases out of ten they will never learn to be engineers.

Another thing is, that to those that really are entitled to that name, the title of civil engineer itself becomes meaningless, from the fact that one of these boys that are called civil engineers is put upon a par with the man who has been in the profession thirty or forty years, and that title is of no use to him. Whether it is practicable to stop it I do not know, but the sooner it is stopped the easier it is stopped. When we have gone on for four or five years in doing this thing, it is very difficult to stop it, more so than if it had only gone on four or five months.

A MEMBER OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS: I would second that motion. I come from an institution that does that thing, and I wish it could be abolished.

THE CHAIRMAN: The chair is in doubt as to the legitimacy of the motion. At present the chair decides that it is not in order. This meeting is a meeting held by the two societies jointly for a special purpose. In order to arrange for it, a joint committee has been appointed. The chair is of opinion that this meeting as such, cannot perpetuate that committee nor direct it to consider any subject. Each of the societies must act for itself on such a question, and, if a joint committee is advisable, then it must be created by the separate action of the two societies, each according to

its own rules. But this decision of the chair need not detract from the moral effect of the excellent suggestion made in several speeches and by Mr. Welch, and by the seconder of his motion, in which I heartily concur. I should be glad to see the granting of degrees restricted in accordance with the suggestion. Meanwhile, unless some gentleman desires to appeal from the decision of the chair—a step which will be welcome, as relieving the chair from responsibility in the matter—this motion is ruled out of order.

Gentlemen, in concluding this most interesting and timely debate, permit me to call your attention to what may be called its net result. Several things seem to have been settled by it, besides the innumerable things which have been thrown out to stimulate further inquiry and debate.

We have settled upon the necessity of a wide education, if we wish to raise a high standard. We have settled upon the necessity of practical training, somewhere in the outset of the work of the young engineer. How shall we get both of these things? We have got to learn more than our fathers, and yet not live longer. As Prof. Thompson has forcibly shown, the period of study is limited by nature. The necessary time and efficiency is not going to be gained by taking the old curriculum and shifting from one thing to another, by giving up the old-fashioned studies and putting in a little of the new-fashioned studies. Change in methods, not merely subjects of instruction, will help us much. I am satisfied that there is an immense amount of useless labor put upon boys, under the name of mental discipline. Take the study of Latin and Greek, for instance. Two-thirds of the time employed in getting the lesson every day is spent in the turning over of the leaves of a dictionary—mere mechanical exercise. Yet it is thought dishonorable to have a "pony," or translation, which is nothing in the world but a dictionary so arranged that you don't have to work your elbow to find words, that is all. The method of teaching modern languages is much better, and it ought to be applied to ancient languages. We must teach them quicker or give them up. Similar reform can be carried even into exact science. Take, for instance, Professor Thompson's remarks in respect to algebra, which are exactly in point.

Another matter of great importance has been suggested and universally admitted, namely, the difficulty of knowing beforehand whether young men are fitted for what they are going into. Nothing is more difficult than this. Life is full of men who have mistaken their vocations. One of the best things about a preliminary

course of practice for engineers would be, I think, that men naturally unsuited for engineers would be sifted out before it became too late for them to change their plans and preparations for life.

Now what is the testimony of this debate as to the actual result of the experiment of preliminary practical training, so far as it has anywhere been tried?

When men like Professor Thurston and Professor Thompson, who have distinct plans, and are engaged in really scientific experimenting in the matter, come forward with their results, they are entitled to great respect. They tell us just what we want to know. Professor Thompson's testimony as to the relative progress of those who came to the Worcester Free Institute after an apprenticeship in ordinary shops, and those who came without any apprenticeship, and took the course in the workshop of the Institute, is, I venture to say, the hardest blow that Mr. Holley's plan has yet received from any objector. The opinion of other instructors on the same point would be valuable. But it is only fair to say that Mr. Holley looks to something more than an ordinary apprenticeship; and so the comparison drawn from experience at Worcester is not wholly fair to him. It should also be remembered that the establishment of such training-shops as those at Worcester, and Hoboken, and Ithaca, and some other places, requires money endowments of no mean extent, while Mr. Holley's scheme can be tried, where it is applicable at all, in commercial establishments already existing.

The meeting was then adjourned *sine die*.

COMMUNICATIONS.

THE following papers, intended to form a part of this discussion, were received before or during the meetings. They are appended in alphabetical order.

PROF. RICHARD AKERMAN, *of Sweden.*

In Sweden all education is free, all the teachers being paid by the government. Some of the technical schools, however, were originally founded by private means, in consequence of which their teachers get their pay partly from the government and partly from the income of private donations. According to the different degrees of knowledge required for admission, the technological schools in Sweden are divided into three kinds.

For admission to the schools of art, the lowest of the three, no more knowledge is wanted than what is acquired in the ordinary public schools. The most prominent of the above named, the School of Art in Stockholm, has about 1700 male and 800 female pupils.

Between the schools of art and the Technological Institute in Stockholm, which is the highest technical school of Sweden, there is an intermediate kind of technical schools, which have more moderate terms of admission than those of the Technological Institute, but much higher than those of the schools of art.

For admission to the Technological Institute, in which the School of Mines is incorporated, the amount of knowledge required is as follows: two grades of algebra, trigonometry, stereometry, geometry, and the elements of chemistry and physics. In general knowledge, the absolutely necessary requirements are very insignificant, as it is not important to have more than a passable knowledge of the history of Sweden, and except the Swedish, of one other living language, usually the German. Nowadays, however, by far the greatest part of the pupils have passed the high schools, and therefore have a thoroughly good general knowledge. The number of pupils at the Technological Institute is about 270. The course has been, and is still, three years, but last winter it was decided to make it four years, this to commence from the beginning of next year.

The last year of the course especially, has a practical tendency, the teaching being altogether in applying, and the reason for the above-named decision, to make the term hereafter four years long, is to be sought for in the circumstance that two years have been found insufficient for acquiring a thorough knowledge of mathematics and the natural sciences, which form the foundation of the technical education, and also proper skilfulness in drawing and constructions.

When, as mentioned before, the teaching during the last year is exclusively in applied sciences, the natural consequence is, that it must be essentially diverse, depending upon the branch of engineering the youths are going to embrace, viz., civil, mechanical, architectural, mining and metallurgical, or chemistry. As, however, different degrees of knowledge of the natural sciences are required for different branches of engineering, the teaching, with due regard to this, is alike for all the pupils, only during the first year, and at the beginning of the second year, they must make up their minds to what branch they intend to devote themselves.

The School of Mines is exclusively a school of applied science for those who desire to make mining or metallurgy their special study. The teaching in this school, therefore, corresponds with the last year in the Technological Institute, and the requirement for admission consists of that particular knowledge acquired by those who at the Technological Institute have devoted themselves to mining or metallurgical engineering.

By far the greatest number of ordinary pupils in the School of Mines have therefore finished their preliminary studies at the Technological Institute, but those also who have passed through lower technical schools, and therefore have not taken such extensive preliminary studies, are allowed to enjoy the same teaching as extra pupils, though they are not allowed to pass any examination, and do not get any certificates.

Besides the preliminary theoretical studies, it is stipulated as a condition for admission to the School of Mines, that the candidate for at least two months shall have lived at some mines and iron-works, and during this time shall have tried to the best of his ability to understand the different processes and work there going on. For this purpose the time from the end of the term at the Technological Institute (12th of June), and the beginning at the School of Mines (8th of September), is used; but nearly every year there are several pupils of the School of Mines, who, after they have finished their

terms at the Technological Institute, have taken during several following years situations at mines and iron-works, and not until they have acquired practical experience in order to become more conversant with the theories of the different processes, do they go to the School of Mines.

From the 8th of September to the 1st of May, the teaching in mining and metallurgy, chiefly that of iron, is going on without interruption, in Stockholm, and even the first practical knowledge in mine-surveying, is obtained in the rooms of the school itself; but on the 1st of May the pupils start travelling, and at first pass six weeks at some iron-works in company with and under the superintendence of their teachers. There they have to blow-in a blast-furnace only sixteen feet high, belonging to the school, without any help whatever from professional or other people. Then, they are called upon to produce different kinds of pig-iron suitable for different purposes, and they have to calculate themselves the proper mixtures to obtain this result.

Besides this short blast, which they manage altogether on their own account, they are obliged to watch the working and management of the large blast-furnace belonging to the works very closely, as well as to take part of the manual labor at the ore-calcining kilns and the Lancashire forges.

Having finished these practical studies in blast-furnace working and the process of making malleable iron, they at once proceed to a mine, where they, under the supervision of another teacher, practice surveying, and study in a practical way the extraction of the ore and the general working of the mine. This is continued till the beginning of July, from which time the pupils, under the guardianship of their teachers in the respective branches, visit the most prominent and notable iron-works and mines of the country. These travels go on till the end of July, when the pupils have to write down an account of them, and the impressions received during this time. The nature of these accounts are taken very much into consideration by the teachers, in the determination of the certificates. The final examinations take place at the end of October.

MR. CHARLES MACDONALD, *Member of the American Society of Civil Engineers and of the American Institute of Mining Engineers.*

A recent writer in the *New York Times*, in speaking of education, has said: "Few things have been made plainer within a few years

than the falsity of our system of education as generally followed, the chief defects just now being in *method* and *discrimination*."

Judging from the tenor of the discussion of Mr. Holley's able paper, this view would seem to be very generally held by members of our own profession in regard to technical education; hence the elaborate comparisons of different methods, old and new.

There have been advocates of a purely theoretical system, by which general principles are taught without the aid of practical illustration. Then, again, it has been suggested that the methods of the workshop may with advantage be introduced into the school, and lastly, as Mr. Holley indicates, there is the possibility of reversing the last method, by bringing the school into the workshop.

It does not seem to me that the inadequate results which are too often obtained from our technical schools are due so much to the methods employed as to our own treatment of the individual with whom we have to do.

Between the ages of ten and sixteen the mind is in a condition to receive impressions only; it is, therefore, eminently proper that this period of life should be devoted to the acquirement of what is generally understood as a common school education, in which I would substitute French and German for the dead languages, which have heretofore been so persistently and indiscriminately forced upon the pupil. At the age of sixteen the body is in much greater need of attention than the mind; it may be said to be in a transition state, in which relaxation and change of scene are of the greatest importance. The boy should be taken from school at this age, and allowed a vacation of from six to twelve months, during which time he should be permitted to see as much of the world as practicable, and should be given to understand that he has now arrived at that most important period of life when he must select for himself an occupation. At the end of his vacation, if his preferences are decidedly in favor of the engineering profession, he should be allowed a year's practical contact with that branch of it with which he proposes to connect himself. If he is of a mechanical turn of mind, it would not appear to be difficult to obtain a position for him, without pay, in some manufacturing establishment, where he would be daily brought in contact with the best that is being done, and with the men and methods by which it is accomplished; he would begin to recognize the difficulties under which practical men labor, and at the same time he would see the necessity of a knowledge of practical methods, to the successful application of general principles. This

experience would undoubtedly inspire him with a desire to acquire a knowledge of such general principles, and would furnish the *incentive to study*, which is, after all, the one thing needful; without this the best methods may too often be employed without imparting knowledge, while, on the other hand, if the student has been enabled to see the end from the beginning, he will absorb much that it is important for him to know, even under the most defective system. Great care should be taken in limiting the time spent in preliminary contact with practical life, lest the habit of study be impaired or the student shall have been impressed with a desire to accomplish results without a proper appreciation of the importance of scientific methods. I have mentioned a year as generally sufficient for this introductory work, at the end of which time the student, at the age of eighteen, will be in proper form to enter upon a four years' technical course in a purely theoretical school. This should bring him to the full stature of manhood, well equipped and eager to encounter the difficult problems of an active professional life, and with a store of knowledge at his command, which will enable him to render a good account of the abilities with which he has been endowed.

To conclude briefly, I would adopt the views expressed by Mr. Holley, in so far as they indicate the necessity of a short, practical experience, before technical training begins, but I believe this can best be accomplished by placing the student in a commercially successful manufacturing establishment, or upon some scientifically conducted public work, without pay, and under the direction of the managers of the work solely. Contact with other students, or with expert school-men at this stage, would divert the mind from the main object, which is to acquire a correct idea of what is being accomplished in practical life, and would not tend to develop the habit of self-reliance, or the improvement of the mind in the direction of its greatest capability.

Mr. Isaac Newton, *Member of the Institute of Mining Engineers.*

Sound acquirements in such thoroughly practical professions as those of civil, mechanical, or mining engineering, it seems to me, can only be attained by actual practice; but, before the pupil can take part in real operations, or can even see them with any profit, it is essential that he should be thoroughly grounded in the ordinary academic studies; but he should also have obtained such knowledge of the profession he is preparing himself for, as can be acquired by instruction in a technical school. A pupil at the beginning of his

career, after leaving the technical school, finds out, as soon as he begins to face the realities of his profession, that, instead of having completed his professional education, he had only begun it. From what little I have seen of the course of technical students, I am disposed to think that the first two years or thereabouts, after graduation, will give the young man more accurate knowledge regarding his fitness for his work than can be got from the school itself.

It seems to me that it would be a wise plan for our polytechnic schools to divide their degrees into two steps or stages; the first to be bestowed on the student on graduation, and the second after an examination, to be held after, say, the first two years of his course. During this period the candidate should keep a record of his technical reading, with his observations thereon, of the engineering operations he has witnessed, and of the work he has been engaged upon. The character of these records, and an examination based thereon, should be the ground of the award of his final or full degree. I feel convinced that if this plan, or one similar to it, could be carried out, a few years would witness a marked improvement in the rising generation of our engineers, civil, mechanical, and mining.

There is another matter, it strikes me, which ought to receive more attention than it does in the polytechnic schools. I mean the purely business training that is essential to financial success in all the professions under discussion; a knowledge of bookkeeping, and the methods of making up accounts, will give the engineer who has this knowledge a vast advantage over one who is deficient in this particular. I have on more than one occasion seen young men about iron establishments and engineering workshops, whose sole technical knowledge was acquired by their own unsupervised reading, and by watching what was going on about the works, promoted over the heads of those who had graduated from technical schools. The young graduate, full of enthusiasm for his profession, is too often prone to look with a sort of contempt on such acquirements, but he may rest assured that a familiarity with business methods is a vital necessity for his permanent success.

Let me call attention to one more point. All will admit the vast importance of accurate knowledge respecting the cost of production, and the comparative cost of various methods and processes; all will at the same time admit the difficulties of finding this out by watching the operations of various works. Pupils cannot be too strongly impressed with the importance of such knowledge, and they should be taught to carefully utilize every opportunity to get it.

MR. CHARLES B. RICHARDS, *Member of the American Society of Civil Engineers.*

What follows refers only to mechanical engineering, particularly to machine construction, in relation to which the subject under discussion is of the greatest importance.

The system in large American shops (particularly in New England) of the subdivision of labor, and of employing one man on one kind of work only, is so prevalent, that good, practical, general mechanics are not being produced. The system of employing apprentices who shall learn general work in the machine shop is in disfavor, first, with the employer, because to carry it out fully does not correspond with the system of subdivision; second, with the employé, because skill in one kind of work is soon acquired, and this done, he finds the tendency of the subdivision system is to keep him engaged on the one kind of work he has become skilful in.

The places of foremen and directing mechanics who, from the general character of their training and practice under the old system, became fitted for their positions, cannot be filled from the ranks, in shops where the system of labor subdivision prevails. Good planer hands, or lathe workmen, or fitters, etc., are being trained from men who enter the shops at low wages, and devote an indefinite time to practice in a single process, in which their labor soon becomes remunerative, and to which it is therefore devoted exclusively. Hence, a general knowledge of processes is not acquired. Our directing mechanics and engineers, who in former years, and almost up to the present time, were raised from the bench, must hereafter be trained in the schools, and it is to be confessed that their education is a perplexing problem.

President Holley has, in my opinion, touched the keynote, in assuming that practical instruction should precede that of the scientific school, for an interest in the sciences, and facility in acquiring them, are developed as the application of the sciences to the arts becomes apparent, and are increased in proportion as these relations are more evident.

What the nature of the preliminary practical instruction should be, is the important question. It should be of a character to insure the greatest saving of time to the pupil in attaining the object of his aim. It should not extend over so much time that the pupil will be deterred from attempting the scientific school course. It should be strictly preparatory to the theoretical course.

I do not think this preliminary study should consist of, or, in-

deed, should necessarily comprise practical work with tools in the shop, for so many arts are here brought together, that almost the first question which arises is, which one of them shall be practiced? Shall it (for example) be that of the pattern-maker, or of the moulder, or of the machinist? It is evident that a general knowledge of all is essential to the engineer, and a certain amount of skill in all, perhaps not in one more than in another, would be desirable, but can the time be afforded for this? It is a question whether, in a course of preliminary study, opportunities for general observation, carefully directed, are not more useful than those for putting one's own hand to the plough.

I believe the best training, preparatory to the theoretical course, can be obtained by about two years of hard work in the general duties of the office of a directing engineer of works, who should direct the instruction, and should of course be a cultivated practitioner, who will look after the interests of his pupils. In such a position the student can be given the best of opportunities to study, at the drawing-table, the details of machines and of processes, the construction and carrying out of which he ought to have opportunities of attending to carefully in the shop. The discipline of the office will be most useful to him. Drawing, one of the arts he is to practice, will be acquired in a way which will serve to give a clear and practical aspect to subjects whose mathematical treatment he will encounter in his subsequent theoretical studies. The time necessary for acquiring some skill with the pencil and pen will be saved from the school course, and will also be well improved in the study of approved examples of modern construction, rather than the models of obsolete practice which are found in many school cabinets.

I believe it to be hardly practicable to organize a system of very profitable preliminary instruction, in which the practical working in the shop with tools is a feature, for even under a competent instructor, most boys would need to practice elementary processes for an unprofitably long time, in order to warrant their being permitted to attempt advanced work, when the risk of a costly failure from lack of skill is considered. It is probable that many manufacturers of machinery would regard the kind of training in shop manipulation which would be the most profitable to the student, with much the same kind of feeling that the enlightened patient would regard a course of surgical practice by prospective medical students.

It is probable that a plan could be systematized for having pupils taken into the offices of engineers whose qualifications and positions

are favorable for the purpose. One argument in favor of this plan is, that if, after the school course is completed, the pupil should find time for a course of practice in manipulations, he will find himself much better fitted to enter upon this with profit to himself and to the shop where he works, than he would have done when younger, and before his studies in the office had taught him where to direct his attention and efforts; and it is my opinion that, if he cannot afford the time for this last course, he will be better off without it than he would have been if this had been substituted for the preliminary office course.

PROF. R. H. RICHARDS, *Member of the American Institute of Mining Engineers.*

The two questions considered. I. Should a course of study in works precede, accompany, or follow that in the scientific school? II. Is it practicable to organize practical schools in engineering works?

The office of instruction seems to be to train the individual to observe. Observers note only what are to them the salient points of a subject. The individual must therefore be given sufficient familiarity with a subject to know what are the salient points to experts, in order that he may take note of them.

Practice before theory.—A carpenter, of twenty-four years of age, who has done nothing but mark with a square, cut off, and drive nails for eight years, has a mind used to a very few simple operations, and entirely unfit for gaining the greatest profit from the scientific school. He has a mind squared to a certain base-line, and one which can be taught only by a method which starts and builds up with reference to that base-line. Practice at the first undoubtedly brightens the mind, but when the novelty has entirely worn off, and nothing but routine work is done, the mind becomes dimmed more and more to other things and less receptive for the training of scientific schools. Men can be seen everywhere who, when once they have got into a narrow routine of work—and it requires only a short time to bring them there—are callous to all wider and larger views of their subject, and to whom the scientific-school training will have no interest or appeal, unless brought down to and built upon their own little rules of things. The order in which information may be brought to practical usefulness seems to be, 1st, observe; 2d, record intelligently; 3d, assimilate, digest, classify, compare; 4th, promul-

gate the results or bring them to usefulness. The routine man cannot observe nor record.

Theory before practice.—The school-man, if properly taught, has learned the principles of observation and classification, but he lacks the practice, or, in other words, he does not know what the salient points are which the expert should know, and his observation will therefore be excessively one-sided, the cause of most of the so-called difference between theory and practice.

The school-man tries to "square nature with the book," and fails because he has never had sufficient opportunity to test himself. He needs to learn that his own judgment is one of the elements to be observed, and that it must be placed in the balance along with the other facts obtained. This can only be done by testing himself, and trying himself side by side with people and things. The graduate of a scientific school, unless special pains has been taken to put him upon original work or upon work in which he must *mind the helm* himself, will have to start at the very beginning, in order to make himself a thoroughly practical leader. The school-man when he finally gets to work, will find that he does not know many things which the books would have taught him if he had been awake to their meaning. This surely is not the most healthful order for gaining independence of thought.

An alternative: An educated mind, serving in engineering work, and then in the scientific school.—This arrangement will undoubtedly give the best training of all. The mind is stimulated, rationalized, and widened by a liberal education, by a free contact with men of equal age, both superior and inferior in intellect. With such a preparation, the mere routine of engineering work will not absorb and obscure the mind; it will simply be a groundwork upon which the causes and effects of things can be seen to act. The mind after such a practical training is in a thoroughly receptive condition for what the scientific school may have in store for it; the views recorded in books are brought side by side with one's own, and intelligently compared with them. But while this order of things seems better fitted than any other, it has one difficulty, and that is, the expense and time required for it are more than can generally be afforded by our young men. The question at once comes before us then, should education be planned for the few or the many?

Synchronous arrangement of practical and theoretical work.—This seems to offer the most practical solution for the education of the majority. In this arrangement the mind is constantly stimulated in

its theoretical study by the practical application of what is learned. This brings the mind and soul together, strengthened by each other for the one purpose of gaining independence. There may be, however, a very considerable variation in the arrangement of a synchronous course. (*a.*) The practical side may be emphasized at the start, and the theoretical at the end of the course. (*b.*) The two may be evenly distributed. (*c.*) The theoretical side may be dwelt upon more fully at first, the practical side towards the end. My own view of the matter favors this last arrangement. The student at first should be given enough practice to stimulate his mind and explain the uses of things; but it is at the end of his course, when he is about to step away from his alma mater, that he needs to know himself, and to have proved himself side by side with people and things; it is toward the latter part of the course, therefore, that the practical part should be emphasized.

Thus far I have dwelt upon the first question, *i. e.*, that of sequence. The second question seems to me to be poised in this way: Are we to depend upon practical scientific schools, or upon educational engineering works?

In Europe the schools, mines, and works are more commonly under one control. Students can be more readily accommodated with practical advantages. In this country, however, the schools and works are carried on by different people; besides, the works are under people who believe that they possess facts which are unknown to any one else. These facts they regard in a certain sense as their capital. I fear that the time will never come in the United States, when large corporations can be made to believe that it is for their own interests to educate men who will soon be able to take charge of other similar works.

The introduction of practical work into the mining course, by the use of smelting and ore-dressing laboratories, at the Massachusetts Institute of Technology, has proved of the greatest benefit to the students. The work is upon a scale varying from one hundred pounds of ore to two or three tons, and gives a great deal of scope for testing the economy and efficiency both of the processes and of the individuals. As their laboratories have been developed from year to year, the students have steadily bettered their attainments. The work in these laboratories taken together with annual visits to mining regions by the classes, and with careful studies of the mines and works, have thus far given results which are most satisfactory and encouraging.

MR. J. DUTTON STEELE, *Member of the American Society of Civil Engineers.*

The deficiency in our system of educating young men for the pursuits of an engineer are well known to those who have been largely engaged in directing our public improvements; it is the development of the theoretical to the sacrifice of the practical. To some extent this is the case in all professions, but in that of the engineer the lines dividing the two are strongly marked, and the latter attains an importance which equals if it does not surpass the former.

The first duties of a young man on leaving college are entirely practical, and for such he has little or no preparation, and he soon discovers that he has to enter upon new fields of investigation in which he has to work haphazard and without the aid of text-books and teachers, where slow progress is made in the absence of strong mechanical proclivity, or an acute sense of observation. It is not therefore surprising that many, after spending the best part of their life for study, discover that they have mistaken their calling and give up the pursuit, whilst others, feeling that there is a future before them in the vast fields of practical science, manfully struggle with the obstructions they so unexpectedly find in their way, and after spending double the time in the school of practice, that they have already done in that of theory, find at length that they have become something more than "hewers of wood and drawers of water" to those who are their inferiors in technical education.

Practical knowledge is something more than the education of the hand or the eye of the student to skilful manipulations, it is also a knowledge of the nature of things as they exist, of the imperfections rather than the perfections of the objects with which he has to deal, and although his education is an aid to him in his after pursuits, much that he has learned has to be stored away for a remote future, or is lost in the pressing needs of the present.

For a clearer view of this subject let us assume that theoretical education is a knowledge of the forces of nature, and that practical education is a knowledge of the repellent powers in nature to the application of these forces, and we will see that the latter includes a larger field of study than the former, and one that is more difficult to accomplish, as it has not, thus far, been the subject of classification or system, and is dependent upon the opportunities and powers of original observation. Bessemer's invention for producing steel rails was so simple that any novice in chemistry could understand it, yet he had to study the repellent forces to his process which existed in

the iron ores of England for seven years before he could produce satisfactory results. In the early history of our public improvements, it was not unusual to find whole series of structures failing from imperfect foundations, yet the schools had done their work well, the plans were good, but those who had charge of carrying them out had, probably, never seen a bridge founded, and were incapable of forming a correct judgment as to the requirements of the cases as they were presented to their minds in endless variety. We have had large amounts of money expended in our coal mining districts in attempts to extinguish fires in coal-mines by anti-combustible gas, overlooking the practical fact that the burning mass was generating a repellent gas in larger volume and of greater intensity than could be produced by artificial means, and which would prevent the contact of the extinguishing material with the fire. The locomotive is the offspring of practice, and it was not until it had obtained nearly its present perfection (but not its present power), that scientists resolved its several parts into due proportions, and led the way to its enlargement and greater efficiency.

Far be it from my intention to undervalue the pursuits of science; it is the only true foundation upon which to erect a structure of professional ability, but it is not *the* structure, and unless the builder learns how to put his materials together, the structure will not stand. Nor can the schools be looked to for the production of such minds as Telford, Stephenson or Bessemer; they are special creations of Providence for the advancement of mankind in industrial pursuits; they overreach the schools and conduct their investigations in new fields where they are guided largely by the lights of practice. But we should expect the schools to put forth young men capable of making themselves practically useful in the pursuits they have elected for their life-work, and to shield capital, on the one hand, from the blunders of uneducated pretenders, and on the other, from that class of scientific devotees who whittle down their theories to so fine a point that they will not stand.

This can only be done by uniting the theoretical and practical in the schools of technical education, by giving them equal prominence in the system, and by letting them go hand in hand as far as possible in the progressive stages of mental and physical development. Other systems must result in an unnecessary waste of time and money, and in disappointment to the subject.

It is however more easy to point out the defect than to discover the means of remedying it. The medical student has his dissecting-

room and hospital, the chemical student his laboratory, the student of natural history his museum, all of which are complete illustrations in themselves, but the student of engineering cannot have his examples within the range of college buildings, nor can he have unquestionable control of them, distributed as they are over wide extents of country. If, however, it is admitted that the practical is of equal importance with the theoretical, an equal proportion of the school term can be appropriated to each branch of study, and a separate corps of professors assigned to each. In such an arrangement the practical teachers must be governed by circumstances during their half of the school year, but should keep the youth under their personal observation and training during the entire period. In many cases they could obtain employment for them at a nominal compensation or gratuitously, in others their time must be spent in inspection and observation. Surveying they could generally get to do, and if not, they could resurvey what has been surveyed before, and thus perfect themselves in the use of instruments and in calculating quantities; they could obtain the plans of structures, from the most simple to the most elaborate, and calculate the strains upon them, and learn that there is a practical as well as a philosophical problem involved in every operation, from the driving of a spike to the construction of a bridge, and they could enter the manufactories and mines, and gather from them a fund of useful knowledge, even if they were not allowed to assist in the operations.

If it is not considered practicable to so unite the two in a single college course, let them be pursued in alternate years, and so continued until the desired amount of education is obtained. Our present system tends too much towards binding up the minds of our young men in books, and cramps that free range of thought which is necessary to enable them to grasp the multifarious professional demands of our country, or it so depletes their physical energies that they are unfitted for the hard outdoor work of an engineer, and consigns them to the more sedentary duties of the office, in which, useful though they may be, their chances of advancement are comparatively few.

MR. A. L. TYLER, *Member of the American Institute of Mining Engineers.*

The discussion has been very interesting, and I fully agree in the necessity of a basis of general culture—now this can be laid by the time a boy is sixteen. Then, to answer the question, "What shall we do with our boys?" First, let us so prepare them that they shall

get all the advantages of the technical school, which can only be done by making the preparation more practical in its nature. Take the time allotted for education up to twenty-one, which is our American limit. At sixteen put the boy, no matter what his specialty may be, into a machine shop for a year; teach him to chip and file, and to hand-tool a shaft; to be independent of the labor-saving machines, and also teach him to *work*, and to know that a half dollar represents ten hours' labor. Then at seventeen let him go back to the school. His mental powers have only lain dormant, and a short time will place him on full equality with his comrades, and in advance of them, owing to his practice. His drawings from models will be far more easily and thoroughly acquired. After his three years' study, at twenty, let him take the final year in the shop, learning setting up, fitting of parts, the use of patterns, etc.

Now at twenty-one he is ready to start. Suppose he is to be a blast-furnace man. He goes to the weigh scales and weighs iron. His weights will be accurate, his iron properly graded, and his yard systematically arranged. If his scales get out of order he will adjust them himself. He will gradually gain the confidence of the old founder, who despises "theory blowers," and believes in nothing but practice, but who fully appreciates his honest work and system, and he will absorb information as a sponge does water.

In short, what we want is not so much to improve the technical school as to see that the student shall get all it has to give.

DR. H. WEDDING, *of Germany.*

Our German institutions for technical education have been so often mentioned, that I think it may be perhaps not quite uninteresting to you to hear some more particulars about the technical schools, as far as they are designed for teaching mining and metallurgy.

There are two essentially different kinds of institutions. One kind, which are called Mining Schools (Bergschulen or Steigerschulen), and another, which are called Mining Academies (*Bergakademien*). The first are established in the largest mining districts, and are only designed for the education of working-men; those workmen who show a desire for a higher education, and excel in industry and good behavior, are selected by the owners or the directors, and sent to the mining schools, where they get free lessons, their expenses for living being often paid besides. They have there the opportunity to learn all that is necessary to become good *foremen* (steiger), but it is not designed to make *engineers* out of them.

Sometimes, it is true, one of these young men will show such talent in the school that he will be sent afterwards to a mining academy, but that is only the exception.

The method of education of *engineers*, that is, men who shall have the faculty to manage mines and melting works of every description and size, control the men, superintend the assays, make constructions of machinery, furnaces, etc., is quite in another way. A young man who would become a mining or metallurgical engineer, ought to go through in the first instance a general school (*gymnasium*, *realschule*), where he gets only a general education, not the least a technical one. When about twenty years old he leaves this school, and goes to the *Bergakademie*, the real technical school. These mining academies are in Germany sometimes institutions for mining branches alone, and sometimes include other branches, as civil engineering, architecture, etc.

We professors of these academies, or rather most of us, try to get up the preliminary general education as high as possible, and prefer the scholars who have a finished general education, finding that these generally make quicker progress than others, though their mathematical and chemical knowledge are very low on the average.

Between the general school and entering of the mining academy, one or two years of practical work in mines or smelting works were formerly prescribed; but this prescription is now omitted, it being free to the scholar to do so still, or come at once to the academy, because we are of the opinion that every young man should be fitted by the general school morally as well as intellectually to take care of himself.

But, as the young men or their parents generally ask the professors for their advice, and this advice is always given for some practical work before entering the academy, most young men go first to a mine, a colliery, or a smelting works for at least one year. For a diligent young man we think one year generally sufficient to get the practical knowledge which is undoubtedly necessary for the understanding of the lectures given at the academy.

The purpose of this practical year is neither to make a workman out of the young scholar, nor an engineer. He cannot in a year become equally a good puddler, coal-cutter, smelter, etc. He can only get a practical idea which will enable him to follow the lectures without obliging the professors to dwell upon practical things in a tedious manner. It is not necessary that the student shall see all different kinds of mines and furnaces. If he has studied a colliery well, he will

understand easily the description of a lead mine; if he has studied a blast-furnace well, he will also understand the description of the puddling process, etc.

I always advise the young men to take one branch, for instance puddling, quite earnestly. In working with their own hands, they not only learn, but appreciate, the powers of a laborer; they know what they can demand from a man. I speak here from my own experience. After I finished the *gymnasium*, I went by the advice of our well-known German metallurgist, Mr. Karsten, to a Silesian iron-mill, and learned to work a charcoal finery till I was quite master of this process. I found it afterwards very easy to manage and understand all other iron processes, and I appreciate and value to-day, in my present situation as consulting engineer to the Prussian government for its metallurgical works, the knowledge which I got in those two years of practical work.

The mining academy takes three years. The question arises, is it good to mingle practice with the studies? From my own experience I must question that. The vacations may be well adapted to continue the practical work, or to make excursions, to travel, etc., but study and practical work together seem very irrational.

After the studies at the mining academy are finished, the young man is generally twenty-five years old, and thinks now about securing for himself a situation, which will enable him to be married at thirty. He has now no more time in which to work as a workman. He now begins his career at a mine or a smelting-works; at first working just according to his inclination for mechanical or chemical pursuits, either in a draughting office or in a laboratory, whence he makes his way as an engineer to the place for which his ingenuity and his assiduity may fit him.

So the young man leaves the mining academy not *as* an engineer, but with all the foundation to *become* a good and useful engineer.

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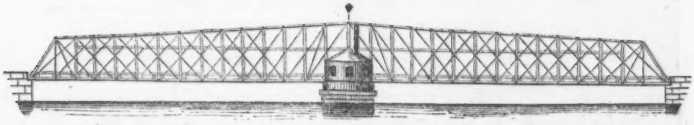

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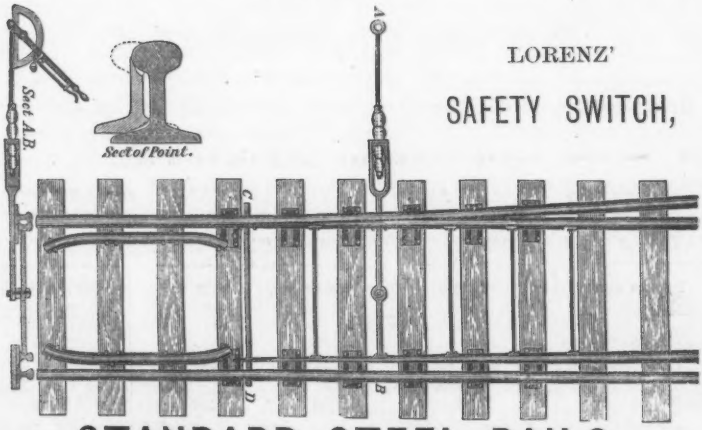

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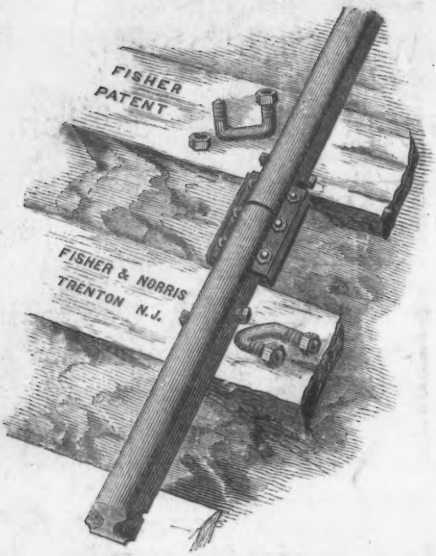

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SECTION

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